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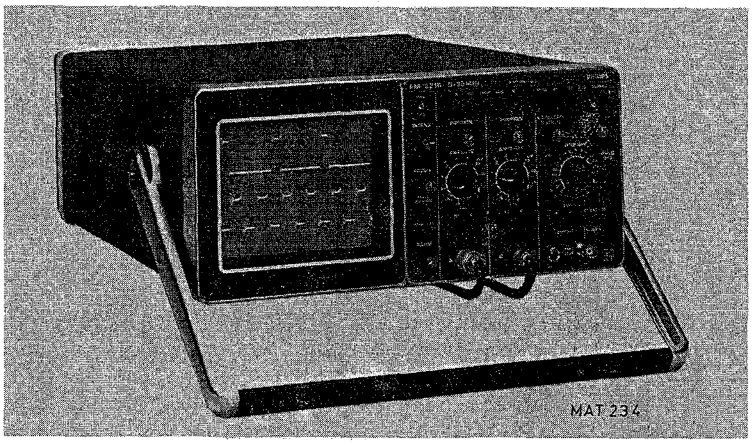

Instruction manual
Gerätehandbuch
Notice d'emploi et d'entretien

35 MHz Dual channel oscilloscope
35 MHz Zweikanal-Oszilloskop
Oscilloscope 35 MHz à double trace

PM 3216

(9444 032 16..1)

9499 440 20202 790330

IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

IMPORTANT

RECHANGE DES PIECES DETACHEES (Réparations)

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Note:	*The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*
Bemerkung:	*Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*
Remarques:	*Cet appareil est l'objet de développements et améliorations continuels. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

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PRINTED IN THE NETHERLANDS

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1. General information

1.1. INTRODUCTION

The 35 MHz dual-channel oscilloscope PM 3216 is a compact, lightweight instrument, featuring ergonomic design and extensive measurement capabilities.

A large 8 x 10 cm screen, with internal graticule lines, a high intensity trace together with features such as TV triggering, switchable trigger modes and adding modes for the vertical channel, make this instrument suitable for a very wide range of use.

A double-insulated power supply allows the frame ground to be directly connected to floating ground circuits provided this ground does not carry live potentials.

Interference by ground currents, as is frequently experienced with grounded oscilloscopes, is also substantially reduced.

Use of the oscilloscope in the field is further facilitated by optional battery operation.

Warning: The frame ground (and the probe's ground lead) must not be connected to live potentials.

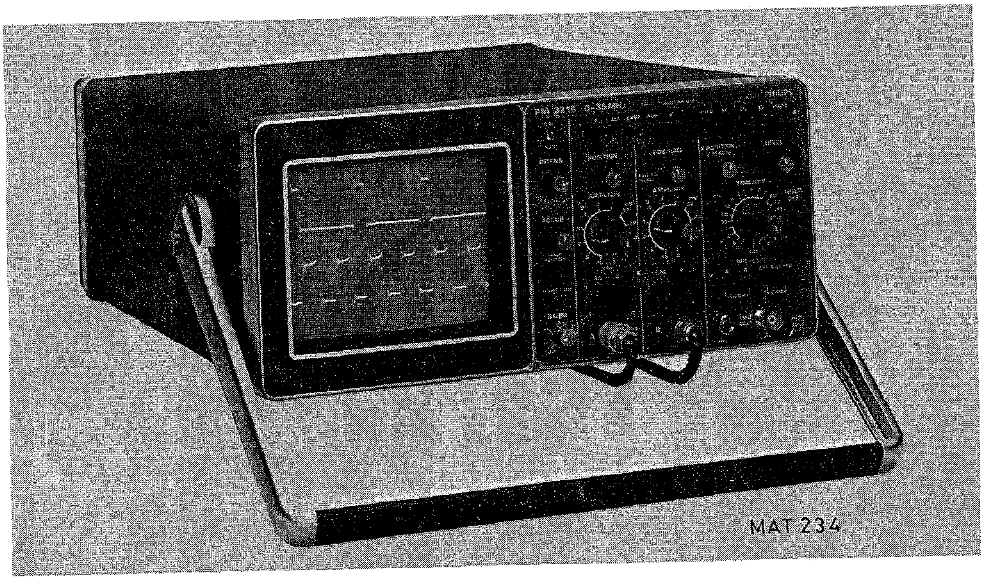


Fig. 1.1. 35 MHz dual-channel oscilloscope PM 3216

1.2. CHARACTERISTICS

This instrument has been designed and tested according to IEC Publication 348 for Class II instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

Properties expressed in numerical values with stated tolerances are guaranteed for ambient temperatures of +5 °C ... +40 °C unless stated otherwise. Numerical values without tolerances are typical and represent the characteristics of an average instrument. The data apply after a warming-up period of 30 minutes.

	Designation	*Specification*	*Additional Information*
1.2.1.	**C.R.T.**		
	Type	D14-125 GH/08	
	Measuring area	8x10 divisions	1 div. equals 1 cm
	Screen type	P31 (GH)	P7 (GM) optional
	Total acceleration voltage	10 kV	
	Graticule	Internal	Cont. variable illumination
1.2.2.	**Vertical amplifier**		
	Display modes	Channel A only Channel B only A and B chopped A and B alternated A and B added	
	Channel B polarity	Normal or inverted	
	Response:		
	Frequency range	DC : 0 ... 35 MHz (–3 dB) AC : 2 Hz ... 35 MHz (–3 dB)	
	Rise time	⩽ 10 ns	
	Pulse aberrations	⩽ ± 3% (⩽ 4% pp)	Measured at 6 div. amplitude and applied rise time of ⩾ 1 ns
	Deflection coefficients	2 mV/DIV ... 10 V/DIV	1-2-5 sequence
	Continuous control range	1 : ⩾ 2,5	
	Deflection accuracy	± 3 %	
	Input impedance	1 MΩ/20 pF	
	Input RC time	0.1 s	Coupling switch to AC
	Maximum permissible input voltage	400 V, d.c. + a.c. peak	
	Chopping frequency	≈500 kHz	
	Vertical positioning range	16 divisions	
	Dynamic range	24 divisions	
	Visible signal delay	⩾ 2 divisions	At 10 ns
	C.M.R.R. in A-B mode	⩾ 40 dB at 1 MHz	After adjustment at d.c. or low frequencies
	Cross talk between channels	–40 dB or better at 10 MHz	Both attenuators in the same setting
	Instability of the spot position:		
	Temperature drift	⩽ 0,3 div/hour	

	Designation	*Specification*	*Additional Information*
1.2.3.	**Time base**		
	Time coefficients	0.5 s/DIV ... 0.1 μs/DIV	1-2-5 sequence
	Continuous control range	1 : ⩾ 2.5	
	Coefficient error	± 3%	
	Magnification	10x	
	Magnifier error	± 2%	
	Maximum effective Time coefficient	10 ns/DIV	
1.2.4.	**Triggering**		
	Source	Ch.A, Ch.B, Composite, External and line	
	Trigger mode	Automatic, normal AC normal DC and TV	TV line or frame switched by TIME/DIV switch TV line : .2 μs/div ... 20 μs/div TV frame : 50 μs/div ... 5 s/div
	Trigger sensitivity	Internal : 1.0 DIV. at 35 MHz External: 0.2 Vpp at 35 MHz Ext ÷ 10 : 2 Vpp at 35 MHz	
		TV int.: 0.7 DIV	Sync pulse amplitude
		TV ext.: 0.15Vpp	Sync pulse amplitude
	Triggering frequency range	AUTO : 20 Hz ... ⩾ 35 MHz AC : 5 Hz ... ⩾ 35 MHz DC : 0 Hz ... ⩾ 35 MHz	Typically, stable triggering can still be obtained at 50 MHz and 2 div. or 1 Vpp amplitude
	Level range	AUTO : Proportional to peak-to-peak value of trigger signal. AC, DC : 16 div. at Internal trigg., 3,2V at external trigg., and 32V at ext. ÷ 10	+ or –8 div and + or – 1,6V referenced to centre of screen + or – 16V referenced to centre of screen
	Triggering slope	Positive or negative going	
	Input impedance	1 MΩ/20 pF	
	Maximum permissible input voltage	400 V, d.c. + a.c. peak	below 100kHz
	Hold-off time	variable	
1.2.5.	**X Deflection**		
	Source	A,B,EXT.,EXT. ÷ 10 or LINE	As selected by trigger source switch, if TIME/DIV switch is in pos. X DEFL.
	Deflection coefficients	A or B : As selected by AMPL/DIV EXTERNAL : 0.2 V/DIV EXT. ÷ 10 : 2 V/DIV LINE : 8 divisions	
	Deflection accuracy	± 10 % in A or B	
	Frequency range	DC : 0 ... 1 MHz (–3 dB) AC : 5 Hz ... 1 MHz (–3 dB)	
	Phase shift	⩽ 3° at 100 kHz	
	Dynamic range	24 divisions	For frequencies ⩽ 100 kHz
1.2.6.	**Calibration generator**		
	Output voltage	1.2 Vpp	Square wave
	Accuracy	± 1 %	
	Frequency	≈ 2 kHz	

1.2.7. Power supply

Designation	*Specification*	*Additional Information*
AC supply:	Double insulated	Safety class II, IEC 348
Nominal voltage range (on line-mains voltage adaptor)	110, 127, 220 or 240 Vac ± 10 %	
Nominal frequency range	50 ... 400 Hz ± 10 %	
Power consumption	28 W max.	At nominal mains voltage
DC supply:		
Voltage range	22-27 Vd.c. 20-28 V	Floating input With relaxed specifications
Current consumption	1.1 A max.	
Capacity to earth	110 pF	Measured with rubber feet on earthed metal plate of 1 m^2
	23 pF	Measured 30 cm above earthed plate of 1 m^2

1.2.8. Environmental characteristics

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, THE NETHERLANDS.

Ambient temperature		
Rated range of use	+5 °C ... +40 °C	
Limit range of operation	−10 °C ... +55 °C	
Storage and transport conditions	−40 °C ... +70 °C	
Humidity	According to IEC 68 Db	
Bump	1000 bumps of 10 g, ½ sine, 6 ms duration in each of 3 directions	
Vibration	30 minutes in each of three directions, 10-150 Hz; 0.7 mm p-p and 5 g max. acceleration	
Altitude		
Limit range of operation	5000 m (475 mbar) (= 47.5 K Pa)	in open air
Limit range of transport	15000 m (100 mbar) (= 10 K Pa)	
Recovery time	30 minutes if instrument temperature is raised from −10 °C to +20 °C at 60 % relative humidity	

Electromagnetic interference meets VDE Störgrad K.

1.2.9. Mechanical data

Dimensions:		
Length	445 mm	Handle and controls excluded
Width	300 mm	Handle excluded
Height	137 mm	Feet excluded
Weight	7.9 kg	

1.2.10. Z-mod input and facilities for 2 extra output circuits (see chapter 3.6.)

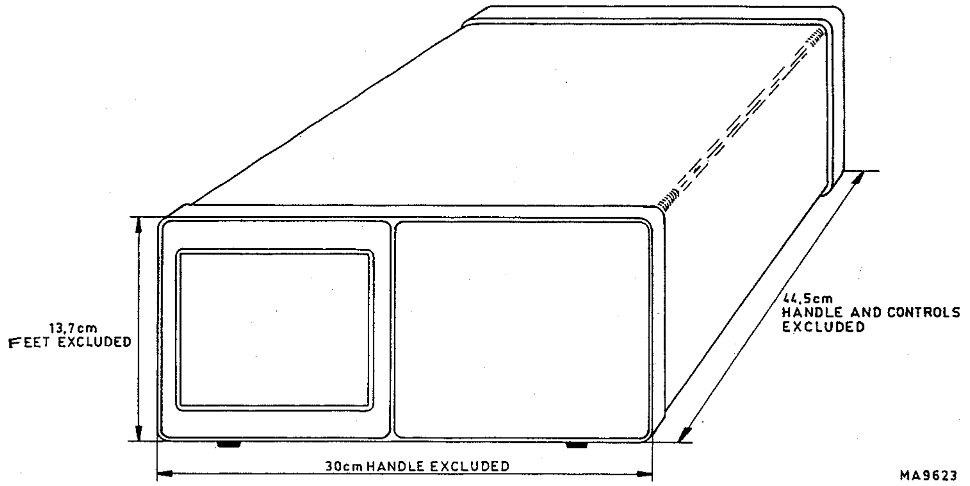

13,7cm
FEET EXCLUDED
44,5cm
HANDLE AND CONTROLS
EXCLUDED
30cm HANDLE EXCLUDED
MA9623

Fig. 1.2. Dimensions

1.3. ACCESSORIES

1.3.1. Supplied with the instrument

Front cover
2 BNC 4 mm adaptor
2 Probes
Instruction manual

1.3.2. Optional

PM 8925	Passive probe set 10 : 1 (1.5 m) 40 MHz
PM 8925L	Passive probe set 10 : 1 (2.5 m) 40 MHz
PM 8921	Passive probe set 1 : 1 (1.5 m) 15 MHz
PM 8921L	Passive probe set 1 : 1 (2.5 m) 15 MHz
PM 8940	Isolation amplifier
PM 8943	1 : 1, 10 : 1 and 100 : 1 650 MHz FET-probe
PM 9355	Current probe
PM 8910	Polaroid anti-glare filter
PM 9380	Oscilloscope camera
PM 8971	Camera adaptor
PM 8962	19" Rack mount adaptor
PM 9366	Collapsible viewing hood
PM 8980	Closed long type viewing hood
PM 8901	Rechargeable battery pack 330 V d.c./24 V d.c.
PM 8991	Trolley
PM 8992/01	Accessory pouch
Trimming tool kit	

See also Chapter 3.5. "INFORMATION CONCERNING ACCESSORIES".

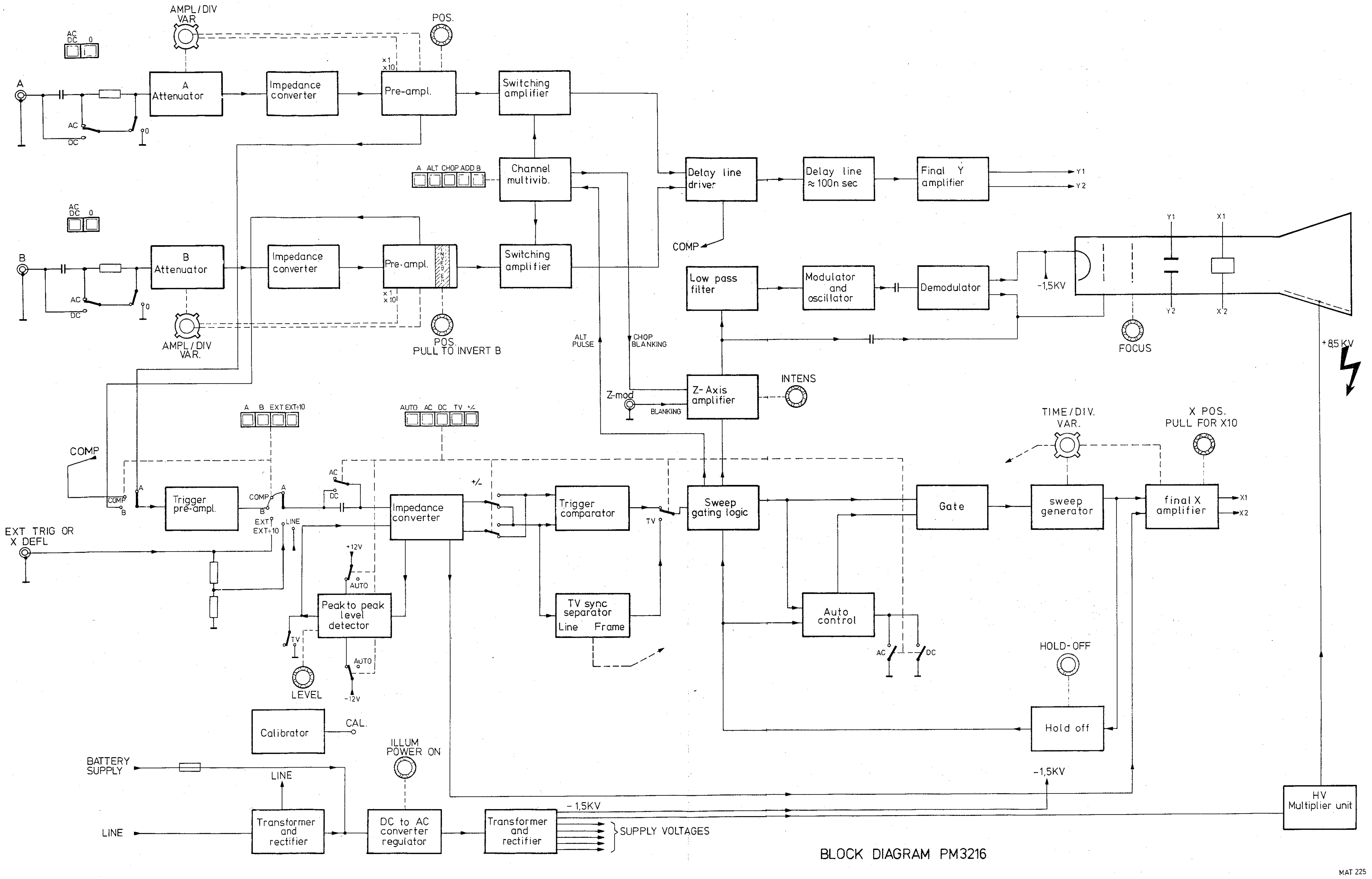

AMPL/DIV VAR.
POS.
AC DC 0
A
A Attenuator
Impedance converter
x1 x10
Pre-ampl.
Switching amplifier
AC
DC
0
Channel multivib.
A ALT CHOP ADD B
Delay line driver
Delay line ≈ 100n sec
Final Y amplifier
Y1
Y2
COMP
B
B Attenuator
Impedance converter
Pre-ampl.
INVERTER
Switching amplifier
AMPL/DIV VAR.
POS. PULL TO INVERT B
Low pass filter
Modulator and oscillator
Demodulator
-1,5KV
Y1
X1
Y2
X2
FOCUS
+8,5 KV
ALT PULSE
CHOP BLANKING
Z-mod
BLANKING
Z- Axis amplifier
INTENS
A B EXT EXT:10
AUTO AC DC TV +/-
COMP
TIME/DIV. VAR.
X POS. PULL FOR X10
Trigger pre-ampl.
COMP
B
EXT
EXT:10
LINE
Impedance converter
+/-
Trigger comparator
TV
Sweep gating logic
Gate
sweep generator
final X amplifier
X1
X2
EXT TRIG OR X DEFL
+12V
AUTO
Peak to peak level detector
TV
LEVEL
AUTO
-12V
TV sync separator
Line Frame
Auto control
AC
DC
HOLD-OFF
Hold off
Calibrator
CAL.
ILLUM POWER ON
BATTERY SUPPLY
LINE
LINE
Transformer and rectifier
DC to AC converter regulator
Transformer and rectifier
- 1,5KV
SUPPLY VOLTAGES
-1,5KV
HV Multiplier unit
BLOCK DIAGRAM PM3216
MAT 225

Fig. 1.3. Block diagram
Abb. 1.3. Blockschaltbild
Fig. 1.3. Schéma synoptique

1.4. BLOCK DIAGRAM DESCRIPTION (Fig. 1.3.)

1.4.1. Y Channel

The vertical channels A and B for the signals to be displayed are identical, each comprising an input coupling switch, an input step attenuator, an impedance converter and a preamplifier with trigger pick-off.
A channel multivibrator, controlled by the display mode pushbuttons, switches either channel A or channel B to the final Y amplifier via the delay line. The channel multivibrator is operated by a pulse at the end of the sweep, and offers an uninterrupted display of the A and B waveforms in the ALT mode. In the CHOP mode the multivibrator is free-running and provides a chopped display of the two signals. In the ADD position, both switching amplifiers are connecting the signals through thus adding channels A and B. By inverting the B channel amplifier (PULL TO INVERT B) the A-B mode is obtained.

The AMPL/DIV switches provide x1 or x10 gain control of the preamplifier, which offers in conjunction with the step attenuator a full range of deflection coefficients in a 1-2-5 sequence.

1.4.2. Triggering

To initiate sweeps, trigger signals can be derived from the A and B vertical channel preamplifiers, from an external source, or internally from the mains supply (LINE triggering) as selected by the trigger source switch. With A and B pushbuttons both depressed, composite triggering is derived from the delay-line driver stage. The polarity of the trigger signal, negative or positive-going, on which the display will start is determined by changing the output polarity of the impedance convertor.

With the AUTO switch depressed, the peak-to-peak level detector comes into operation. The peak-to-peak level of the signal then determines the range of the LEVEL control.

With AC or DC depressed, the range of the LEVEL control is fixed.

In the TV mode the LEVEL control is inoperative and the TV sync separator is switched into circuit, thus initiating sweeps with line or frame pulses as dictated by the setting of the TIME/DIV switch.

1.4.3. Time-base circuit

For normal internal time-base operation the horizontal amplifier is fed by sweeps from the time-base circuit.

With AUTO depressed, in the absence of trigger signals, the output of the sweep generator is fed back via the hold-off circuit and gate to its input. This causes sweeps to free-run and a resultant trace is displayed on the screen. As soon as the AUTO control circuit detects a trigger (i.e. change in the output of the sweep-gating logic) the sweep is fed back to the sweep-gating logic. This causes the circuit to revert to the normal triggering mode in which sweeps are initiated only by trigger pulses at the input of the sweep-gating logic.

With AC or DC depressed, AUTO control is made inoperative. Sweeps are then only produced provided a trigger signal is present and the LEVEL control appropriately set.
The display can be magnified in the horizontal direction by increasing the gain of the final amplifier.

In the EXT position of the TIME/DIV switch, the sweep generator output to the final amplifier is inhibited and the impedance convertor is connected directly to the final amplifier. In this way, the signals normally selected for triggering, or an external source, can now be used for horizontal deflection.

1.4.4. Hold-off circuit

The hold-off stage, as its name implies, "holds-off" triggers from the input of the time-base circuit until the trace has completely returned and the time-base circuits are completely reset. The hold-off time can be increased by turning the HOLD-OFF control clockwise.

1.4.5. Z-Axis

The Z amplifier provides for the blanking of the trace during the fly-back and hold-off time. In addition, it blanks the sweep in the CHOP mode during the switching transients. Moreover the trace can be blanked by a signal applied to the external Z-mod input.
The l.f. components of the blanking signal are modulated and demodulated before they are applied to the Wehnelt cylinder together with the a.c. coupled h.f. components.

1.4.6. Power supply

The mains (line) supply is transformed and rectified before being applied to a d.c. to a.c. converter.
When the instrument is operated from a battery supply the battery output is connected directly to the d.c. to a.c. converter.
The output of the converter is coupled to a transformer and rectifier which, after rectification, provides the −1.5 kV e.h.t. potential and the circuit supply voltages. The −1.5 kV is also multiplied to 8.5 kV to supply the required total accelerating voltage of ≈ 10 kV.

2. Directions for use

2.1. INSTALLATION

2.1.1. **Safety regulations** (in accordance with IEC 348)

Before connecting the instrument to the mains (line), visually check the cabinet, controls and connectors etc. to ascertain whether any damage has occured in transit. If any defects are apparent, do not connect the instrument to the mains (line).

The instrument must be disconnected from all voltage sources, and any high voltage points discharged before any maintenance or repair work is carried out. If adjustments or maintenance of the operating instrument with covers removed is inevitable, it must be carried out only by a skilled person who is aware of the hazards involved. In normal operation the double-insulated power supply obviates the need of a safety ground.

> **Warning: It must be borne in mind that in all measurements the frame ground of the oscilloscope is raised to the same potential as that of the measuring ground probe connection.**
> **Neither the probe's ground lead nor the frame ground shall be connected to live potentials.**

2.1.2. Local mains (line) connection and fuse protection

Before connecting the instrument to the mains (line), make sure that it is set to the local mains (line) voltage. On delivery the instrument is set to 220 V. If the instrument is to be used with 110 V, 127 V or 240 V supply, the appropriate voltage should be selected by turning the adaptor on the rear panel to indicate the voltage required (see Fig. 2.1.).

The instrument is protected from overloads by a thermal fuse fitted between the mains (line) transformer windings. It can be replaced after having removed the instrument rear panel (see section 2.4.).

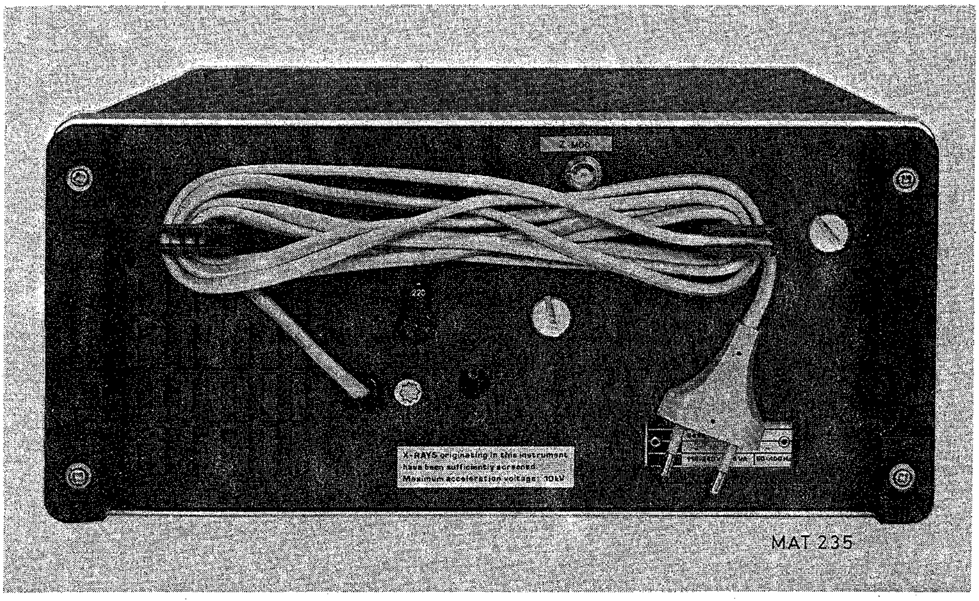

X-RAYS originating in this instrument
have been sufficiently screened.
Maximum acceleration voltage: 10kV
MAT 235

Fig. 2.1. Rear view of the oscilloscope showing the voltage adapter set to 220 V

2.1.3. Connection to an external supply

An external supply or battery of 22 V to 27 V capable of delivering at least 1 A can be connected to the socket on the rear panel (DC power input cord set: 4822 321 20125).

The inner conductor must be connected to the negative pole and the outer conductor to the positive pole, as indicated on the rear panel.

The instrument is protected against overloads and wrong polarity by an internal fuse and diode. This fuse can be replaced after having removed the instrument rear panel (see section 2.4.).

2.1.4. Front cover and instrument position

The front cover can be simply removed by pulling it from the front.
The instrument may be used horizontally or in several sloping positions by using the carrying handle as a tilting bracket. To unlock the handle, simultaneously push in both pivot centre knobs.

2.2. CONTROLS AND SOCKETS (refer to fig. 2.2.)

2.2.1. Cathode-ray tube and POWER controls

ILLUM POWER ON	Continuously variable control of the graticule illumination; incorporates mains (line) switch. Pilot lamp indicates the ON state.
INTENS	Continuously variable control of the trace brilliance.
FOCUS	Allows beam to be focussed for minimum spot size.
TRACE ROTATION	Screwdriver adjustment to align the trace with the horizontal graticule lines.

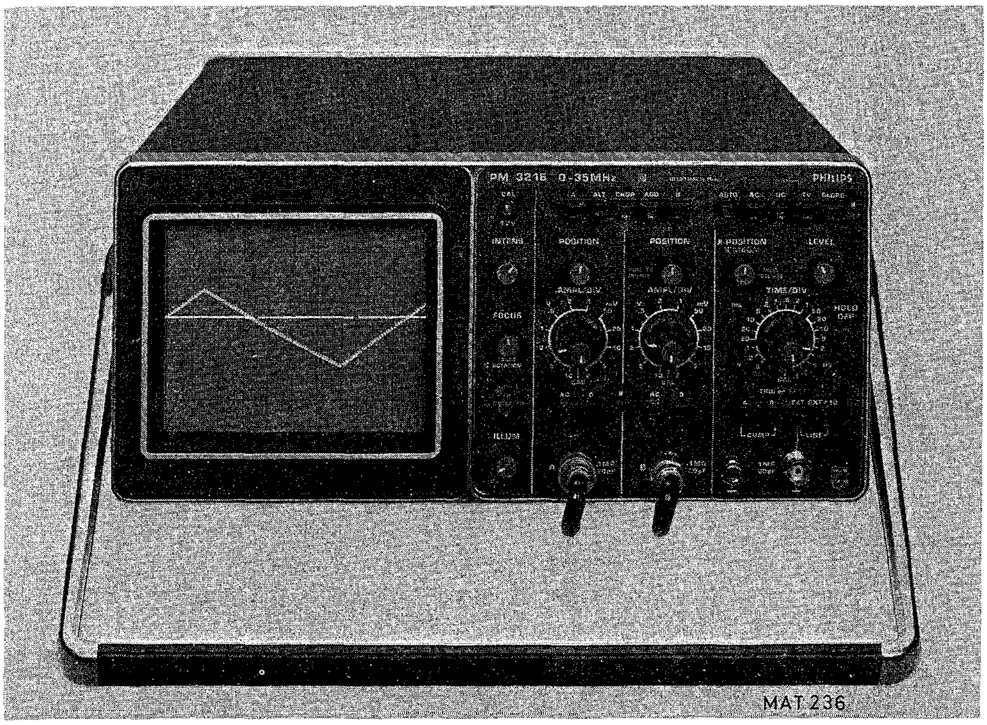


Fig. 2.2. Front view of the oscilloscope showing controls and sockets

2.2.2. Vertical channels

Display mode switch	*Function*
	5-way pushbutton switch selecting the vertical display mode. With all buttons released, the ALT mode is in operation.
A	Vertical deflection is achieved by the signal connected to input of channel A.
ALT	The display is switched over from one vertical channel to the other at the end of every cycle of the time-base signal.
CHOP	The display is switched over from one vertical channel to the other at a fixed frequency ($f \approx 500$ kHz)
ADD	Vertical deflection is achieved by the sum signal of channels A and B (or –B).
B	Vertical deflection is achieved by the signal connected to the input of channel B.
POSITION	Continuously variable controls giving vertical shift of the display.
PULL TO INVERT B	Push-pull switch combined with the channel B POSITION control. When pulled, channel B signal is inverted.
AMPL/DIV (outer knob)	Step control of the vertical deflection coefficients, ranging from 2 mV/div up to 10 V/div in a 1-2-5 sequence.
AMPL/DIV (centre-knob)	Continuously variable control of the vertical deflection coefficients. Note that the deflection coefficient is calibrated only with the centre-knob switched to the CAL position (fully-clockwise).
Input coupling switch	Signal coupling; 2-way pushbutton switch
AC (depressed)	Coupling via a blocking capacitor
DC (released)	Direct coupling
0 (depressed)	Connection between input circuit and input socket is interrupted and the input circuit is grounded.
A	BNC socket for channel A input
B	BNC socket for channel B input

2.2.3. Triggering

Trigger mode switch	*Function*
	5-way pushbutton switch, selecting the trigger mode and the polarity of the trigger transition. With all pushbuttons released AUTO sweep mode is in operation at a fixed range of the LEVEL control.
AUTO	A trace is displayed in the absence of trigger signals. The range of the LEVEL control is proportional to the peak-to-peak value of the triggering signal.
AC	Normal triggering and fixed range of the LEVEL control. DC component of trigger signal is blocked.
DC	Normal triggering and fixed range of the LEVEL control. DC component of trigger signal is passed.

TV	Line or frame synchronisation is obtained as dictated by TIME/DIV switch (frame from .5 s/div to 50 μs/div and line from 20 μs/div to .2 μs/div).
+/–	Sweeps are triggered on positive or negative-going trigger signal transitions. In TV, – must be selected for negative video signals and + for positive video signals.
LEVEL	Control for continuously varying the level of the waveform on which the display is to start.
TRIG OR X DEFL.	See TRIG or X DEFL source switch in section 2.2.4. below.

2.2.4. Horizontal channel

TRIG or X DEFL source switch	*Function*
	4-way pushbutton switch selects the trigger source or the source of horizontal deflection if the TIME/DIV switch is the X DEFL position. With all pushbuttons released source A is selected.
A	Signal derived from channel A.
B	Signal derived from channel B.
COMP (A & B both depressed; inoperative with X DEFL)	Signal derived after the electronic channel switch. Triggering occurs on the waveforms as presented on screen.
EXT and EXT ÷ 10	External signal as applied to the adjacent 1 Mohm//20 pF socket.
LINE (MAINS)	Signal derived from the line (mains) voltage. (Not operable when instrument is supplied by battery.)
X POSITION X MAGN	Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch which increases the horizontal deflection by a factor of 10.
TIME/DIV (outer part)	Selects the time coefficient from .2 μs/div to .5 s/div in a 1-2-5 sequence. Dictates line or frame triggering in TV mode. In position X DEFL horizontal deflection is determined by TRIG or X DEFL switch.
TIME/DIV (centre knob)	Continuously variable control of the time coefficients. Must be in CAL position (i.e. fully clockwise) for the time axis to be calibrated according to the indication of the TIME/DIV switch.
HOLD-OFF	Continuously variable control of hold-off time

2.2.5. Miscellaneous

CAL	Output socket supplying a squarewave of $\approx$ 2 kHz and an amplitude of $1.2\ V_{p\text{-}p} \pm 1\ \%$. To be used for probe compensation and/or checking vertical deflection accuracy.
External supply	Input socket at the rear of the instrument allows the instrument to be operated by an external d.c. supply. Rated supply voltage 22 V to 27 V, current capability > 1 A.
LINE (MAINS) VOLTAGE ADAPTOR	Must be set according to section 2.1.2. before the instrument is connected to the local mains voltage.
Z-mod	See chapter 3.6.

2.3. OPERATING INSTRUCTIONS

2.3.1. Switching on the instrument

Before connecting the instrument to any supply, the instructions given in section 2.1. Installation, should be carefully carried out.

The oscilloscope will meet specifications (see section 1.2.) normally after a warming-up period of approximately 15 minutes. However, if the instrument has been subjected to an extremely cold environment (e.g. left in a car overnight in freezing conditions) and is then brought in for use in a warm room, a warming-up period of sufficient length should be allowed (see 1.2.8.).

2.3.2. Preliminary settings of the controls

This procedure is a general indication of whether the oscilloscope is functioning correctly and provides a suitable starting point before any measurements are made.

Refer to Fig. 2.2. for location of controls.

Set INTENS and FOCUS controls in mid position.

Depress AUTO and select an average time coefficient between 10 μs/div and 10 ms/div with the TIME/DIV switch. With all other pushbuttons normal (not depressed) channel A and channel B traces can be positioned on the screen with the relevant POSITION controls. Set the INTENS control for a display of medium brightness and adjust FOCUS control for well focussed traces.

2.3.3. Input coupling (AC/DC, 0)

AC coupling (pushbutton depressed) is useful to block the d.c. component of a signal. Choice of AC limits the lower frequencies, causing low repetition rate sinewave signals to be attenuated and low repetition rate squarewaves to be distorted. The degree of attenuation is determined by the input RC time (0.1 s). Input RC time is extended by 10 if 10:1 passive probes are employed.

When switching to AC coupling it will take approximately five input RC times before the trace is stabilised to the average value of the input signal.

AC position measurements cannot be made with respect to ground.

0 position disconnects input source and short-circuits input of amplifier to provide zero signal check.

DC coupling (pushbutton released) provides for full range frequency input, i.e. down to d.c.

2.3.4. Use of probes

1:1 passive probes should only be used for d.c. and low frequencies.

Capacitive loading attenuates high frequencies or increases the rise-time of measurement signals (dependent on source impedance).

10:1 passive probes have less capacitive loading; usually about 10 pF to 20 pF. FET probes are superior, especially when measurements are to be taken from high impedance test points or at the upper frequency limit of the oscilloscope bandwidth.

10:1 passive probes must be properly compensated before use. Incorrect compensation leads to pulse distortion or amplitude errors at high frequencies.

For correct adjustment, the CAL output connection can be used (see Fig. 2.3.).

2.3.5. Adjustment of attenuator probes

- Connect the compensation box to socket A and place the tip of the probe on socket CAL.
- Insert a small screwdriver through the hole in the compensation box and adjust the trimmer to obtain a correct display as shown in Fig. 2.3.

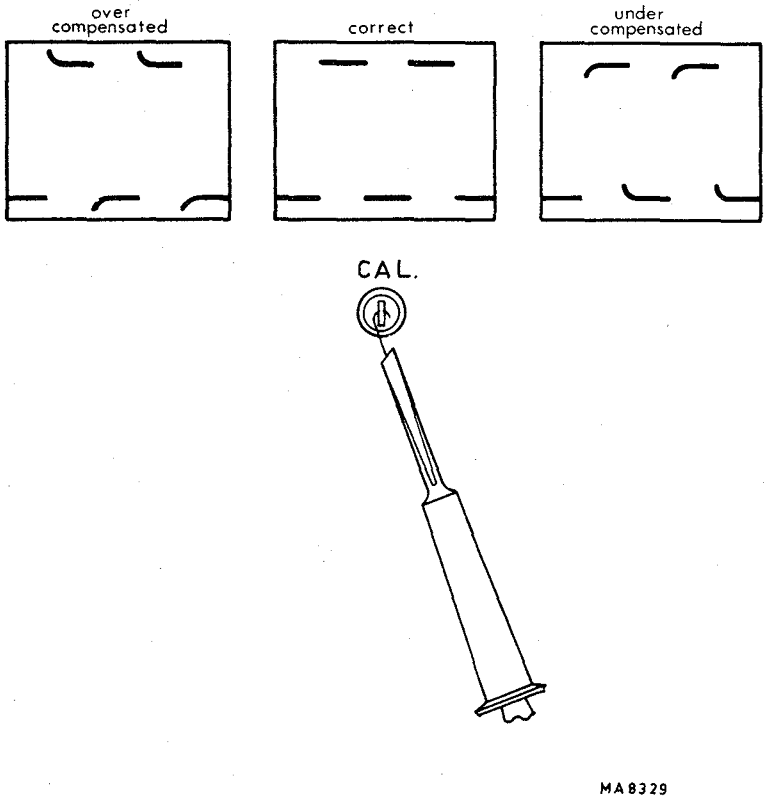


Fig. 2.3. Adjusting an attenuator probe

2.3.6. Selection of chopped or alternate modes

(A ALT CHOP ADD B)

In dual channel operations (CHOP or ALT depressed) the chopped mode (depress CHOP) must be selected for relatively slow sweep speeds (from .1 ms/div to .5 s/div) or at low repetition rates of sweeps occuring, even at high sweep rates. Selection of the ALTernate mode unter these circumstances would make comparisons between waveforms difficult because traces would actually appear to be written one by one. However, when the display is fast enough to be interrupted by the chopping frequency the alternate mode must be selected (depress ALT), usually at sweep rates faster than .1 ms/div.

2.3.7. Differential mode

The A-B mode can be selected by depressing ADD and pulling the channel B POSITION control.
In measurements where signal lines carry substantial common mode signals (e.g. hum) the differential mode will cancel out these signals and leave the remainder of interest (A-B). The capability of the oscilloscope to suppress common mode signals is given by the CMR factor (see Fig. 2.4.).
To obtain the degree of common mode rejection as specified, channel A and B gains must first be equalised. This can be done by connecting both channels to the CAL output connector, and adjusting one of the continuous controls with the AMPL/DIV switch for minimum deflection on the screen.
When passive 10:1 probes are used a similar equalisation process is recommended by adjusting their compensating controls for minimum deflection.

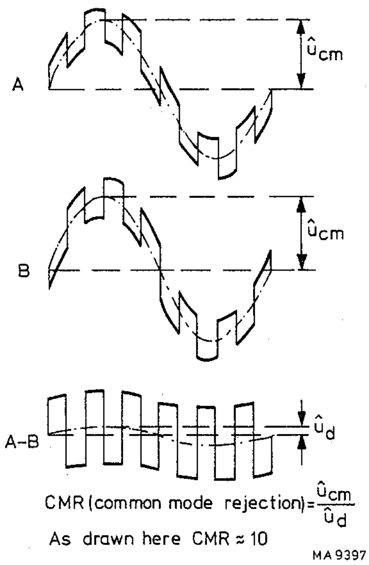


Fig. 2.4. Suppression of common mode signals

2.3.8. Selection of trigger mode

(AUTO AC DC TV +/–)

The AUTO mode is most useful because it provides trace(s) on the screen even in the absence of trigger signals. Furthermore, for a signal amplitude larger than 1 division, this mode provides stable triggering independently of the position of the LEVEL control; its range is automatically adjusted to the peak-to-peak value of the signal selected for triggering.
In this way the setting of the LEVEL control is facilitated at small amplitudes of the trigger signal.
The AUTO mode cannot be employed for signals with low repetition rates (10 Hz or lower) because the sweeps would be able to free run in between triggers. Therefore, for low repetition signals normal triggering must be used (AC or DC depressed).
In normal triggering, sweeps are only initiated with a trigger signal applied and the LEVEL control set appropriately.
With AC or DC depressed the range of the LEVEL control is fixed (+ or –8 divisions or more at the extremes of the LEVEL control with respect to mid screen).
The DC component in the trigger signal can be blocked by depressing AC. This is useful when triggering must take place on a.c. signals superimposed on a large d.c. level.
With AC coupling, the level at which the display starts will change with alterations in the average value of the trigger signal. The trigger level is thus no longer referenced to signal ground. This may cause instability with waveforms that vary in time interval from cycle to cycle. Normally it is preferable to use the DC position.
Slope selection is made with pushbutton +/–. In TV mode – must be selected for negative video signals and + for positive video signals. The LEVEL control is inoperable in the TV mode.
No buttons depressed offers an extra mode of use, a trace is on screen in the absence of a trigger signal, but the LEVEL range is fixed.

2.3.9. Trigger sources

The trigger source is selected by the front-panel TRIG or X DEFL pushbuttons.

```
A       B       EXT     EXT ÷ 10
└─COMP─┘         └─LINE────┘
```

- **Internal triggering** will be most commonly used because it requires only one signal (the input signal) to obtain stable triggering.
- **External triggering.** When tracing many signals it is advantageous to use an external signal for triggering. There is no need to set and reset the trigger controls (LEVEL, SLOPE and SOURCE) on changing the input signal. Furthermore the two A and B inputs remain free for examining waveforms.
- **Selection of trigger source.** In comparing synchronous waveforms, that have unequal repetition rates, always select the signal, that has the lowest repetition rate as the trigger source. Not doing so may lead to double pictures (chopped mode) or untrue time-shifts (alternate mode).
- **Composite triggering.** With internal triggering signals are obtained from either the A channel, the B channel preamplifier stages or, when COMP is selected by depressing both A and B pushbuttons, from the delay line driver stage that follows the electronic channel switch.

  Composite triggering offers three advantages:

  1. In differential mode (A-B measurements) triggering is derived from the differential signal. Triggering is not disturbed by common mode signals.
  2. For one channel operation it is not necessary to switch trigger sources from A to B or vice versa.
  3. In the alternate mode, it is possible to compare signals that are not related in time.

  Note: When composite triggering is employed in dual channel operation (alternate mode), and there is only one signal applied (to A or B input), stable triggering cannot be obtained. This is only normal since the trigger source is also switched from A to B (see Fig. 2.5.).

  When composite triggering is employed in dual channel operation (chopped mode) stable triggering can not be obtained because the system will be triggered by the chopper signal transients.

- **Line (mains) triggering** is useful when the signal input is mains (line) frequency related.

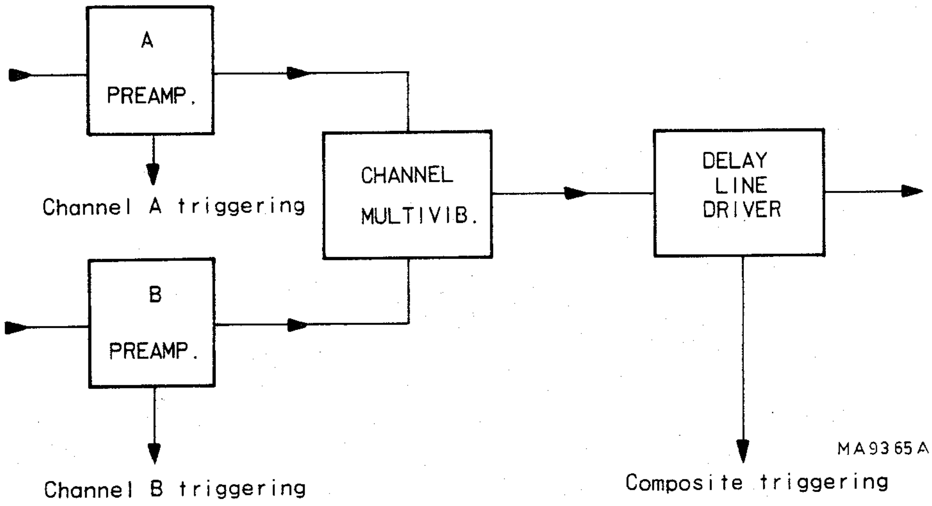


Fig. 2.5. Block diagram of composite trigger circuit

2.3.10. Time-base magnifier

The magnifier is operated by pulling the switch incorporated in the X position control.
When this switch is in the x10 position, the time-base sweep speed is increased 10 times. The sweep time is therefore determined by dividing the indicated TIME/DIV value by 10.

2.3.11. Hold-off.

This control can be used to increase the sweep hold-off time.

2.3.12. XY Measurements

XY measurements are made with the TIME/DIV switch at EXT X DEFL, the source of horizontal deflection being selected by the TRIG or X DEFL pushbutton switch (A, B, EXT, EXT ÷ 10 or LINE)
XY measurements provide a useful means of making frequency or phase shift comparisons by displaying Lissajous patterns.
Measurements can be made up to 100 kHz with less than 3^{0} phase error between horizontal and vertical channels.

The sensitivity for the different XY modes is shown in the following table:

X deflection	Sensitivity
A	AMPL/DIV A ± 10%
B	AMPL/DIV B ± 10%
EXT	0.2 V/DIV
EXT ÷ 10	2 V/DIV
LINE	8 divisions

2.4. PROCEDURES REQUIRED FOR THE REMOVAL OF FUSES, BEZEL AND CONTRAST PLATE

2.4.1. Removing the instrument covers

Always ensure that the mains supply is disconnected before removing any instrument cover plates.
The instrument is protected by three covers: a front panel protection cover, a wrap-around cover with carrying handle, and a rear panel.
To facilitate removal of the wrap-around cover and the rear panel, first ensure that the front cover is in position.

Then proceed as follows:
- Hinge the carrying handle clear of the front cover; to this end, push both pivot centre buttons (Fig. 2.6.).
- Stand the instrument on its protective front cover on a flat surface.
- Slacken the two coin-slot screws located on the rear panel.
- Lift the rear panel and unplug the connector on the power supply board.
- Lift off the wrap-around cover.
- For access to the front-panel, stand the instrument horizontally and snap off the front cover.

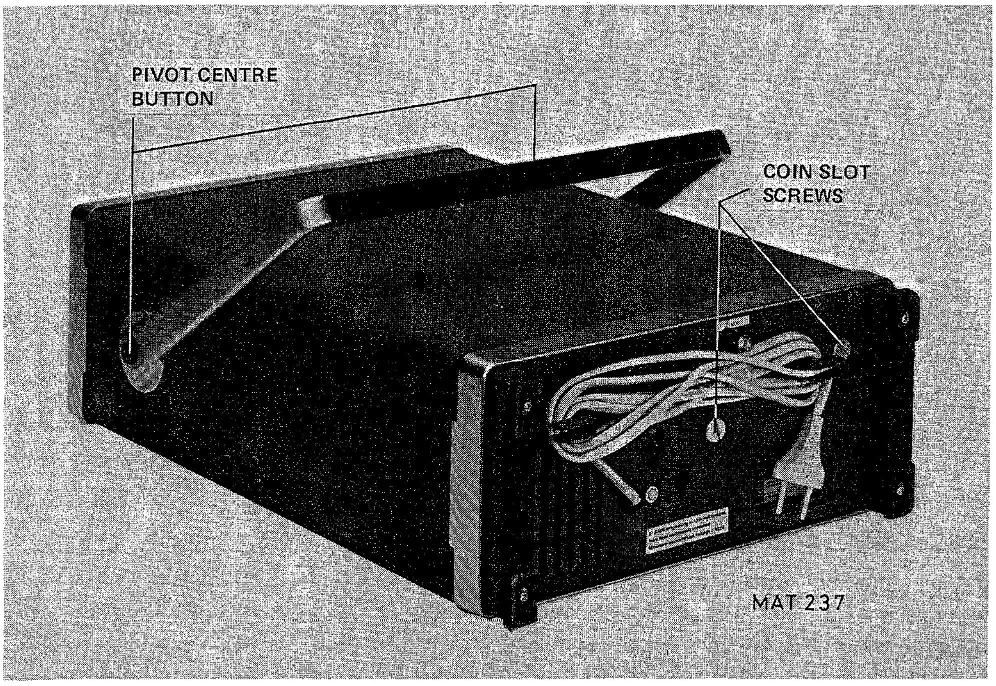


Fig. 2.6. Removing the instrument covers

2.4.2. Removing the mains transformer

- Remove wrap-around cover and rear panel (section 2.4.1.).
- Take the lid off the voltage adapter compartment after removing the 4 cross-slotted screws.
- Remove the 4 cross-slotted screws that hold the lid of the transformer compartment.
- Lift the lid with the attached transformer, simultaneously sliding the wire form between transformer and voltage adapter out of the slit in the transformer compartment.
- The transformer and thermal fuse are then accessible for replacement.

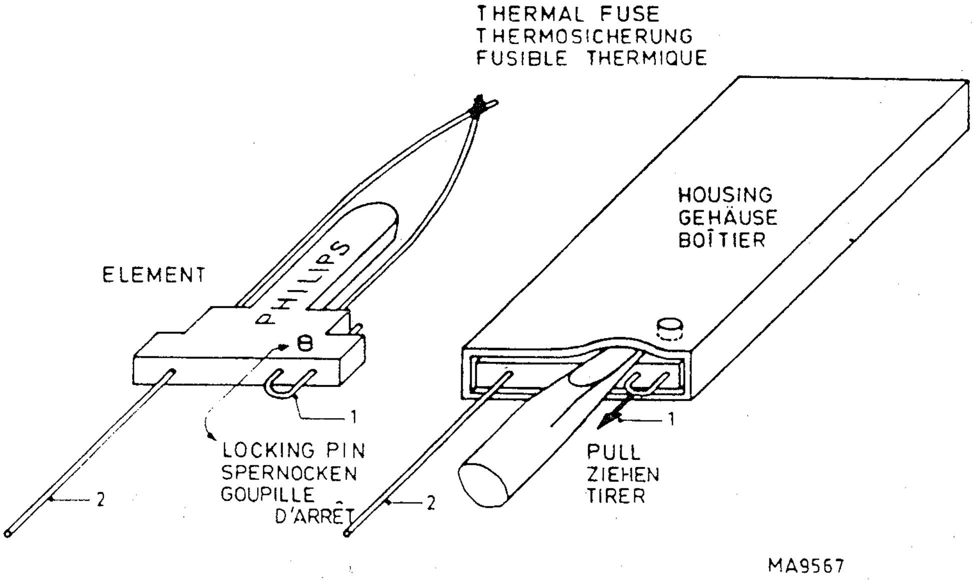

THERMAL FUSE
THERMOSICHERUNG
FUSIBLE THERMIQUE
HOUSING
GEHÄUSE
BOÎTIER
ELEMENT
PHILIPS
8
1
LOCKING PIN
SPERNOCKEN
GOUPILLE D'ARRÊT
2
2
1
PULL
ZIEHEN
TIRER
MA9567

Fig. 2.7. Replacing the thermal fuse

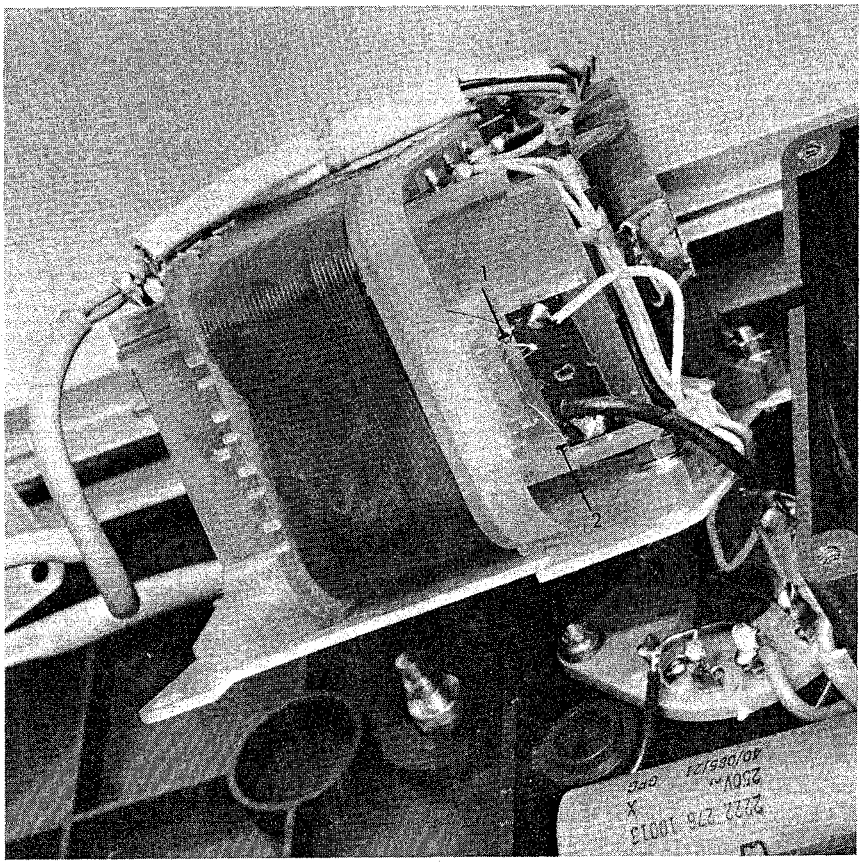


Fig. 2.8. Replacing the thermal fuse

2.4.3. Replacing the thermal fuse F101

- Remove the mains transformer (section 2.4.2.).
- Unsolder fuse terminals 1 and 2 (Fig. 2.7 and 2.8.).
- Only the fuse wire of the old fuse is replaced and not the complete fuse; to this end, bend the housing of the fuse slightly outwards, disengage the locking pin and pull out the wire.
- Take the new fuse and remove the fuse wire out of its housing in the same way as described above.
- Push the new fuse wire into the housing of the old one until the locking pin snaps into the hole. The loop in the fuse wire must point to terminal 1.
- Solder the fuse wire to terminals 1 and 2.

2.4.4. Replacing the fuse F201

- Remove wrap-around cover and rear panel (section 2.4.1.).
- Fuse F201, which is located on the power supply printed circuit board, is now accessible for replacement.

2.4.5. Removing the bezel and the contrast plate

- Take hold of the bezel's bottom corners and gently pull it from the front panel (Fig. 2.9.).
- The contrast filter can be removed by pressing it gently out of the bezel.

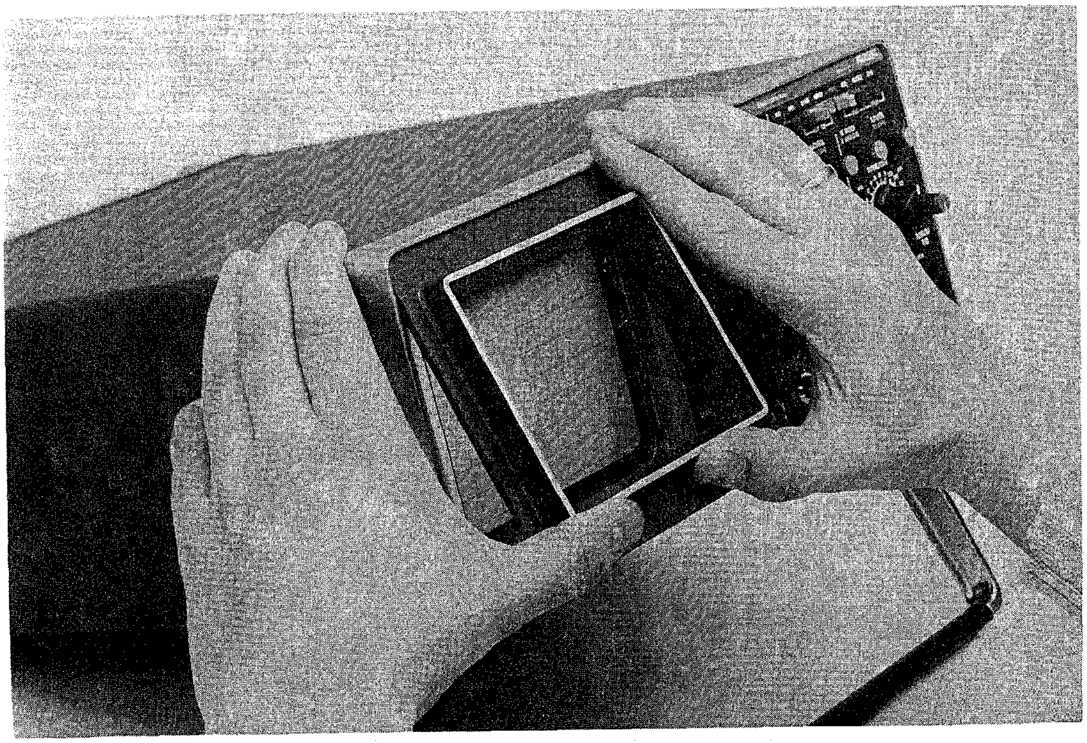


Fig. 2.9. Removing the bezel and the contrast plate

1. Allgemeines

1.1. EINLEITUNG

Der 35 MHz Zweikanal-Oszillograf PM 3216 ist ein leichtes Kompaktgerät. Er ist ergonomisch konstruiert und besitzt vielseitige Messmöglichkeiten.
Ein grosser 8 x 10 cm Bildschirm mit Innenraster, eine sehr helle Schreibspur sowie solche Möglichkeiten, wie TV-Triggerung, umschaltbare Triggerungsarten und Addier-Betriebsarten für den vertikalen Kanal machen das Gerät für einen breiten Anwendungsbereich besonders geeignet.
Eine doppelt isolierte Stromversorgung erlaubt direkten Anschluss der Geräte-Erde an erdfreie Schaltungen, vorausgesetzt diese Mess-Erde führt keine berührungsfährlichen Spannungen.
Interferenzen durch Erdströme, wie sie häufig bei geerdeten Oszillografen vorkommen werden auch wesentlich reduziert.
Der Einsatz des Oszillografen im Freien wird durch wahlweisen Batteriebetrieb erleichtert.

Warnung: Die Geräte-Erde (und die Messkopf-Erdleitung) darf nicht mit berührungsgefährlichen Spannungen verbunden werden.

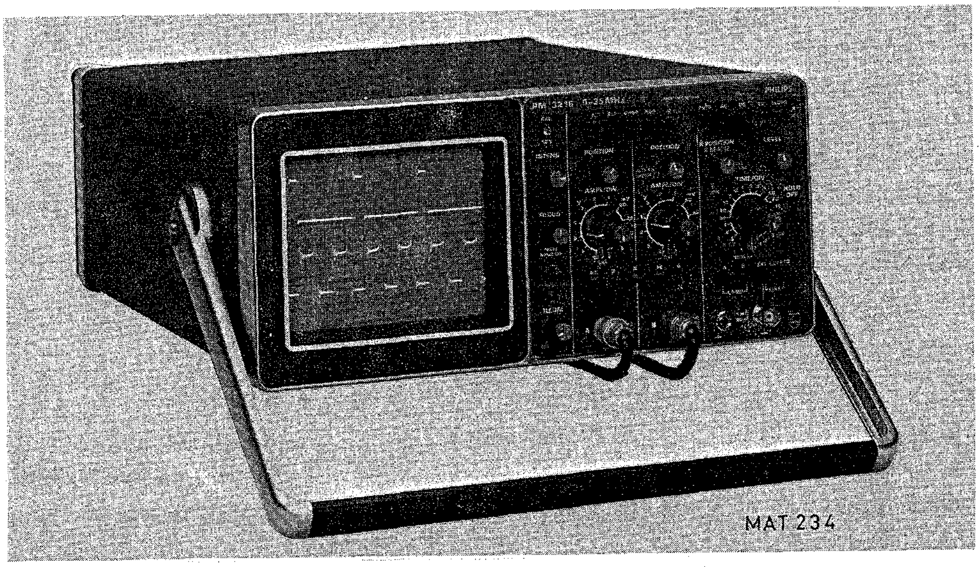


Abb. 1.1. 25 MHz Zweikanal-Oszillograf PM 3216

1.2. TECHNISCHE DATEN

Dieses Gerät ist gemäss IEC 348, Sicherheitsbestimmungen für elektrische Mess- und Regeleinrichtungen, gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Anwender die Hinweise und Warnvermerke beachten, die in der vorliegenden Anleitung enthalten sind.

Zahlenwerte mit Toleranzangaben werden bei Umgebungstemperaturen von +5°C ... +40°C garantiert und nach einer Anheizzeit von 30 Minuten, falls nicht anders angegeben. Zahlenwerte ohne Toleranzangaben sind Durchschnittswerte und dienen nur zur Information.

Bezeichnung	*Beschreibung*	*Nähere Angaben*
1.2.1. Elektronenstrahlröhre		
Typ	D14 - 125 GH/08	
Nutzbare Bildschirmfläche	8 x 10 Teile	1 Teil entspricht 1 cm
Bildschirmtyp	P31 (GH)	P7 (GM) wahlweise
Gesamtbeschleunigungsspannung	10 kV	
Raster	Innenraster	Stufenlos einstellbare Rasterbeleuchtung
1.2.2. Vertikalverstärker		
Darstellungsarten	Kanal A allein Kanal B allein A und B gechopped A und B alternierend A und B addiert	
Kanal B Polarität	Normal oder invertiert	
Kennlinie:		
Frequenzbereich	DC : 0 ... 35 MHz (−3 dB) AC : 2 Hz ... 35 MHz (−3 dB)	
Anstiegszeit	⩽ 10 ns	
Impulsverformungen	⩽ ± 3 % (⩽ 4 % Spitze-Spitze)	Gemessen bei 6 Div. Amplituden mit einer Anstiegszeit von ⩾ 1 ns
Ablenkkoeffizienten	2 mV/div ... 10 V/div	1-2-5 Folge
Stufenloser Einstellbereich	1 : ⩾ 2.5	
Ablenk-Fehlergrenze	± 3 %	
Eingangsimpedanz	1 MΩ//20 pF	
Zeitkonstante der Eingangsschaltung	0,1 s	Kopplungsschalter auf AC
Maximal zulässige Eingangsspannung	400 V	Gleichspannung + Spitzenwert einer Wechselspannung
Chopperfrequenz	≈ 500 kHz	
Vertikale Strahlverschiebung	16 Teile	
Dynamischer Bereich	24 Teile	
Sichtbare Signalverzögerung	⩾ 2 Teile	Bei 10 ns
Gleichtaktunterdrückung in A-B Betrieb	⩾ 40 dB bei 1 MHz	Nach Einstellung bei Gleichspannung oder niedrigen Frequenzen
Übersprechen zwischen Kanälen	−40 dB oder besser bei 10 MHz	Beide Abschwächer in gleicher Einstellung
Instabilität des Leuchtflecks:		
Temperaturdrift	⩽ 0,3 Teil/Stunde	

1.2.3. Zeitablenkung

Bezeichnung	*Beschreibung*	*Nähere Angaben*
Zeitkoeffizienten	0,5 s/div ... 0,1 µs/div	1-2-5 Folge
Kontinuierlicher Einstellbereich	1 : ⩾ 2,5	
Fehlergrenze des Koeffizienten	± 3%	
Dehnung	x10	
Fehlergrenze der Dehnung	± 2%	
Kürzester Zeitmassstab	10 ns/Teil	

1.2.4. Triggerung

Quelle	Kanal A, Kanal B, zusammengesetzt, extern, extern ÷ 10 und Netz	
Triggerungsart	Automatisch, normal Wechselspannung, normal Gleichspannung und TV	TV-Zeile oder Bild geschaltet mit Schalter TIME/DIV TV-Zeile: .2 µs/Teil ... 20 µs/Teil TV-Bild: 50 µs/Teil ... 5 s/Teil
Trigger-Empfindlichkeit	Intern: 1,0 Teil bei 35 MHz Extern: 0,2 V Spitze-Spitze bei 35 MHz Ext. ÷ 10 : 2 V Spitze-Spitze bei 35 MHz TV int.: 0,7 Teil TV ext.: 0,5 V Spitze-Spitze	 Sync. Impuls Amplitude Sync. Impuls Amplitude
Triggerfrequenzbereich	AUTO : 20 Hz ... ⩾ 35 MHz AC : 5 Hz ... ⩾ 35 MHz DC : 0 Hz ... ⩾ 35 MHz	Durchschnittlich ist stabile Triggerung noch erreichbar bei 50 MHz und 2 div., oder 1 V_{ss} Amplitude
Pegelbereich	AUTO: Proportional dem Spitze-Spitze Wert des Triggersignals AC, DC: 16 Teile bei interner Triggerung und 3.2V bei externer Triggerung, und 32V bei: extern ÷ 10 Triggerung	 + oder −8 Teile und + oder − 1,6V bezogen auf Bildschirmmitte + oder − 16V bezogen auf Bildschirmmitte
Triggerflanke	Positiv oder negativ gehend	
Eingangsimpedanz	1 MΩ//20 pF	
Maximal zulässige Eingangsspannung	400 V	Gleichspannung + Wechselspannungs-Spitzenwert unter 100kHz
Sperrzeit (Hold-off)	Regelbar	

1.2.5. X-Ablenkung

Quelle	A, B, EXT, EXT ÷ 10 oder LINE (netz)	Je nach Einstellung des Triggerquelle-Schalters, wenn Schalter TIME/DIV in Stand X DEFL
Ablenkkoeffizienten	A oder B, wie eingestellt mit AMPL/DIV EXTERNAL: 0,2 V/Teil EXT. ÷ 10 : 2 V/Teil LINE: 8 div.	
Ablenk-Fehlergrenze	± 10 % in A oder B	
Frequenzbereich	Gleichspannungskopplung 0 ... 1 MHz (−3 dB) Wechselspannungskopplung 5 Hz ... 1 MHz (−3 dB)	
Phasenverschiebung	⩽3° bei 100 kHz	
Dynamischer Bereich	24 Teile	Für Frequenzen ⩽ 100 kHz

Bezeichnung	*Beschreibung*	*Nähere Angaben*

1.2.6. Kalibriergenerator

Ausgangsspannung	1,2 V Spitze-Spitze	Rechteckspannung
Fehlergrenze	± 1 %	
Frequenz	≈ 2 kHz	

1.2.7. Stromversorgung

Wechselspannungsversorgung:	Doppelt isoliert	Schutzklasse II, IEC 348
Nominaler Spannungsbereich (am Netzspannungsumschalter)	110, 127, 220 oder 240 V Wechselspannung ± 10 %	
Nominaler Frequenzbereich	50 ... 400 Hz ± 10 %	
Leistungsaufnahme	28 W max.	Bei Netz-Nennspannung
Gleichspannungsversorgung:		
Spannungsbereich	22-27 V Gleichspannung 20-28 V Gleichspannung	Erdfreier Eingang Bei gelockerten Spezifikationen
Kapazität gegen Erde	110 pF 23 pF	Gemessen mit Gummifüssen auf einer geerdeten 1 m^2 grossen Metallplatte. Gemessen 30 cm über einer geerdeten 1 m^2 grossen Metallplatte

1.2.8. Einflussgrössen

Die angegeben Daten gelten nur dann, wenn das Gerät gemäss den offiziellen Prüfverfahren kontrolliert wurde. Einzelheiten, die dieses Verfahren und die Fehlergrenzkriterien betreffen, können von der PHILIPS-Organisation Ihres Landes oder von N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, NIEDERLANDE angefordert werden.

Umgebungstemperatur		
Nominaler Betriebsbereich	+5 °C ... +40 °C	
Zugelassener Betriebstemperaturbereich	−10 °C ... +55 °C	
Lagerung und Transport	−40 °C ... +70 °C	
Feuchtigkeit	Entspricht den IEC 68 Db Bedingungen	
Stossfestigkeit	1000 Stösse je 10 g, 1/2 Sinus, Dauer 6 ms in jeder der 3 Richtungen	
Vibration	30 Minuten in jeder der 3 Richtungen, 10-150 Hz; 0,7 mm Spitze-Spitze und 5 g max. Beschleunigung	
Höhe:		
Betriebsgrenzbereich	5000 m (475 mbar) (= 47,5 K Pa)	in Umgebungsluft
Transportgrenzbereich	15000 m (100 mbar) (=10 K Pa)	in Umgebungsluft
Erholungszeit	30 Minuten wenn die Temperatur des Gerätes von −10 °C auf +20 °C erhöht wird, bei 60 % relativer Luftfeuchtigkeit	
Störgrad	Das Gerät entspricht den Anforderungen gemäss VDE, Störgrad K.	

Bezeichnung	*Beschreibung*	*Nähere Angaben*

1.2.9. Mechanische Daten

Abmessungen:		
Länge	445 mm	Ohne Handgriff und Bedienungselemente
Breite	300 mm	Ohne Handgriff
Höhe	137 mm	Ohne Füsse
Gewicht	7,9 kg	

1.2.10. Z-Achsensteuerung und möglichkeiten für 2 extra Ausgänge

Siehe Abschnitt 3.6.

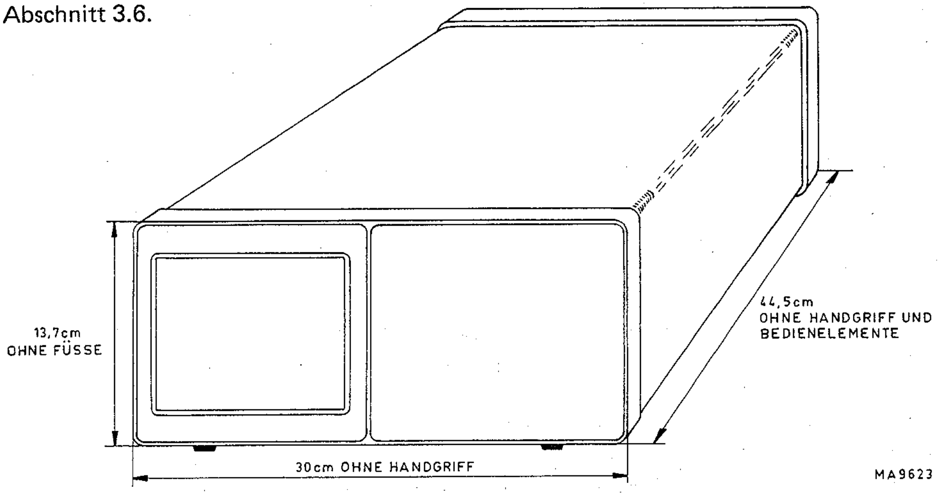


Abb. 1.2. Abmessungen

1.3. ZUBEHÖR

1.3.1. Mitgeliefert

Abdeckhaube
2 BNC 4 mm Adapter
2 Messköpfe
Anleitung

1.3.2. Wahlzubehör

PM 8925	Passiver 10:1 Messkopf (1,5 m) 40 MHz
PM 8925L	Passiver 10:1 Messkopf (2,5 m) 40 MHz
PM 8921	Passiver 1:1 Messkopf (1,5 m) 15 MHz
PM 8921L	Passiver 1:1 Messkopf (2,5 m) 15 MHz
PM 8940	Isolier Verstärker
PM 8943	1:1, 10:1, 100:1 650 MHz FET Messkopf
PM 9355	Strommesskopf
PM 8910	Polaroidfilter
PM 9380	Oszillografenkamera
PM 8971	Kamera-Adapter
M3 ... M5	Steinheil Oszillografenkamera
PM 8962	19" Gestelleinbau
PM 9366	Faltbarer Lichtschutztubus
PM 8980	Geschlossenen langer Lichtschutztubus
PM 8901	Aufladbarer Batteriepack 140 V/24 V Gleichspannung
PM 8991	Rolltisch
PM 8992/01	Zubehörtasche
Trimmwerkzeug	

Siehe auch Abschnitt 3.5. "INFORMATION CONCERNING ACCESSORIES"

1.4. BLOCKSCHALTBILDBESCHREIBUNG (Abb. 1.3., seite 14)

1.4.1. Y-Kanal

Die vertikalen Kanäle A und B für die Signale, die dargestellt werden sollen, sind identisch, jeder Kanal umfasst einen Eingangskopplungs-Schalter, einen Impedanzwandler und einen Vorverstärker mit Triggerentnahme-Stufe.
Ein Kanal Multivibrator gesteuert von den Darstellungsart-Drucktasten, schaltet entweder Kanal A oder Kanal B über die Verzögerungsleitung an den Y-Endverstärker.
Der Kanal Multivibrator wird durch einen Impuls am Ende der Ablenkung betätigt und liefert in Betriebsart ALT eine ununterbrochene Darstellung der A und B Signalformen. In Betriebsart CHOP ist der Multivibrator freilaufend und ergibt eine gechoppte Darstellung der beiden Signale. In Stellung ADD werden die Signale von den beiden geschalteten Verstärkern durchgelassen und addieren somit die Kanäle A und B. Durch Invertierung des B-Kanal Verstärkers (PULL TO INVERT B) erhält man Betriebsart A-B.
Die Schalter AMPL/DIV ermöglichen Verstärkungseinstellung x1 oder x10 des Vorverstärkers der in Verbindung mit dem Stufenabschwächer einen Ablenkkoeffizienten-Bereich in 1-2-5 Folge zur Verfügung stellt.

1.4.2. Triggerung

Zur Einleitung von Zeitablenkungen lassen sich Triggersignale den A und B Kanal Vorverstärkern, einer externen Quelle, oder intern dem Netz (LINE-Triggerung) entnehmen, je nach Einstellung des Triggerquelle-Wahlschalters, Wenn die beiden Drucktasten A und B eingedrückt sind, bewirkt die Verzögerungsleitung-Treiberstufe zusammengesetzte Triggerung.
Die Polarität des Triggersignals, negativ oder positiv gerichtet, mit welchem die Darstellung startet, wird durch Änderung der Ausgangspolarität des Impedanzwandlers bestimmt.
Mit eingedrücktem Schalter AUTO wird der Spitze-Spitze Pegeldetektor wirksam. Der Spitze-Spitze Pegel des Signals bestimmt dann den Bereich des Stellers LEVEL.
Eindrücken von AC oder DC ergibt einen festen Bereich des Stellers LEVEL.
In Betriebsart TV ist Steller LEVEL nicht wirksam und die TV-Synchronisier Trennschaltung wird eingeschaltet und leitet auf diese Weise, je nach Einstellung des Schalters TIME/DIV mit Zeilen- oder Bildimpulsen Ablenkungen ein.

1.4.3. Zeitablenkschaltung

Für normalen Zeitablenkbetrieb erhält der Horizontalverstärker Sägezahnspannungen von der Zeitablenkschaltung.
Wenn AUTO gedrückt ist und keine Triggersignale vorhanden sind wird der Ausgang des Ablenkgenerators über Sperrschaltung und Tor an seinen Eingang rückgekoppelt. Dies verursacht Freilauf der Zeitablenkung und eine resultierende Leuchtspur wird auf dem Schirm sichtbar. Sobald die Steuerschaltung AUTO einen Trigger ermittelt (das heisst eine Veränderung im Ausgang der Zeitablenk-Logik) dann wird die Ablenkung an die Zeitablenk-Logik rückgekoppelt. Dadurch kehrt die Schaltung zur normalen Triggerungsart zurück bei der Ablenkungen nur von Triggerimpulsen am Eingang der Zeitablenk-Logik ausgelöst werden.
Wenn AC oder DC eingedrückt ist, wird Betriebsart AUTO unwirksam.
Zeitablenkungen werden dann erzeugt, wenn ein Triggersignal vorhanden ist und Steller LEVEL entsprechend eingestellt ist.
Durch die Verstärkung des Endverstärkers zu vergrössern lässt sich die Darstellung in horizontaler Richtung dehnen.
In Stellung EXT des TIME/DIV Schalters wird der Ausgang des Ablenkgenerators zum Endverstärker gesperrt und der Impedanzwandler ist direkt mit dem Endverstärker verbunden. Auf diese Weise können nun die normalerweise für Triggerung gewählten Signale oder eine externe Quelle für Horizontalablenkung verwendet werden.

1.4.4. Sperrschaltung

Die Sperrstufe (hold-off) hält die Trigger solange vom Eingang der Zeitablenkschaltung fern, bis die Leuchtspur gänzlich zurückgekehrt ist und die Zeitablenkschaltungen vollständig rückgestellt sind. Die Sperrspannungszeit kann eingestellt werden mittels die Stufenlose "Hold-off" regler.

1.4.5. Z-Achse

Der Z-Verstärker dient zur Austastung des Bildes während des Rücklaufes und der Sperrzeit. Ausserdem wird während der Schaltspitzen in Betriebsart CHOP die Ablenkung ausgetastet.
Die Niederfrequenzkomponenten des Austastsignals werden moduliert und demoduliert bevor sie zusammen mit den wechselspannungsgekoppelten Hochfrequenzkomponenten dem Wehnelt Zylinder zugeführt werden.
Weiter kann das Bild ausgetastet werden von ein signal angeschlossen an den externen Z-Achsensteuerungsbuchse (Z-mod).

1.4.6. Speisung

Die Netzspannung wird erst gewandelt und gleichgerichtet und gelangt dann an einen Gleichspannungs-Wechselspannungswandler.
Wenn das Gerät mit Batteriespeisung betrieben wird, dann wird der Batterieausgang direkt an den Gleichspannungs/Wechselspannungswandler gelegt.
Der Ausgang des Wandler ist gekoppelt an einen Transformator und Gleichrichter, der nach Gleichrichtung das —1,5 kV Hochspannungspotential liefert und die Speiseleitungen der Schaltung zur Verfügung stellt. Die —1,5 kV wird ausserdem auf 8,5 kV verstärkt um die erforderliche Gesamtbeschleunigungsspannung von 10 kV liefern zu können.

2. Gebrauchsanweisung

2.1. INBETRIEBNAHME

2.1.1. Sicherheitsvorschriften (den IEC 348 Bedingungen entsprechend)

Vor Anschluss des Geräts ist eine Sichtkontrolle des Geräts vorzunehmen, um festzustellen ob das Gerät möglicherweise während des Transports beschädigt wurde. Wenn irgend welche Defekte wahrgenommen werden darf das Gerät nicht an das Netz angeschlossen werden.
Vor Wartungs- oder Reparaturarbeiten ist das Gerät von allen Stromquellen zu trennen und müssen alle Hochspannung führenden Teile entladen sein. Wenn danach eine Kalibrierung, Wartung, oder Reparatur am geöffneten Gerät unter Spannung unvermeidlich ist, so darf das nur durch eine Fachkraft, die die damit verbundenen Gefahren kennt, geschehen. Normalbetrieb erübrigt die doppelte Isolierung der Stromversorgung bei die Notwendigkeit einer Schutzerde.

WARNUNG: **Es ist zu beachten dass bei allen Messungen die Gehäuseerde die gleiche Spannung wie die Messköpferde erreicht.
Weder die Messköpferdleitung noch die Gehäuseerde dürfen mit berührungsgefährlichen Spannungen verbunden werden.**

2.1.2. Örtlicher Netzanschluss und Sicherung

Vor dem Anschliessen an das Netz ist zu prüfen, ob das Gerät für die örtliche Netzspannung eingestellt ist.
Das Gerät wird eingestellt auf 220 V geliefert. Falls das Gerät mit einem 110 V, 127 V oder 240 V Netz verwendet wird, ist die geeignete Netzspannung mit Hilfe des Spannungsumschalters an der Geräterückwand so einzustellen dass er die erforderliche Spannung anzeigt (siehe Abb. 2.1.).
Das Gerät ist durch eine zwischen den Wicklungen des Netztransformators angebrachte Thermosicherung gegen Überlastungen geschützt.
Die Sicherung lässt sich nach Abnahme der Gehäuserückwand ersetzen (siehe Abschnitt 2.4.).

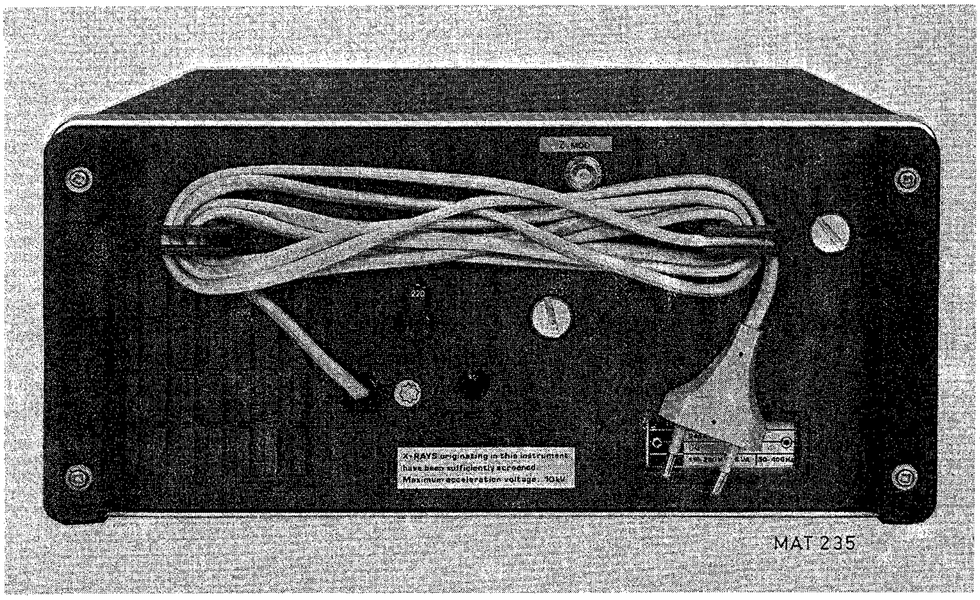

X-RAYS originating in this instrument
have been sufficiently screened.
Maximum acceleration voltage: 10kV
MAT 235

Abb. 2.1. Rückansicht des Oszillografen mit Spannungsumschalter in 220 V Stellung

2.1.3. Anschluss an eine externe Stromversorgung

Eine externe Stromversorgung oder eine 22 V bis 27 V Batterie die zumindest 1 A liefern kann lässt sich an die Buchse an der Geräterückwand anschliessen (Kabel und Stecker: 4822 321 20125).
Der Innenleiter muss an den Minuspol und der Aussenleiter an den Pluspol angeschlossen werden, wie an der Rückwand angegeben. Gegen Überlastungen und Polaritätswechsel ist das Gerät durch eine interne Sicherung und Diode geschützt. Die Sicherung lässt sich nach Abnahme der Gehäuserückwand ersetzen (siehe Abschnitt 2.4.).

2.1.4. Abdeckhaube und Betriebslage

Die Abdeckhaube lässt sich auf eine einfache Weise durch Ziehen von der Gerätefront abnehmen.
Das Gerät darf in waagrechter Lage oder mit Gebrauch des Tragbügels als Kippbügel in verschiedenen Schrägstellungen aufgestellt werden. Um den Tragbügel zu entriegeln, gleichzeitig die beiden Lagerzapfenknöpfe eindrücken.

2.2. BEDIENUNGSELEMENTE UND BUCHSEN (siehe Abb. 2.2.)

2.2.1. Elektronenstrahlröhre und POWER-Einstellelemente

ILLUM	Stufenlose Einstellung der Rasterbeleuchtung; zugleich Netzschalter.
POWER ON	Signallampe zeigt Betriebszustand (ON) an.
INTENS	Stufenlose Einstellung der Bildhelligkeit.
FOCUS	Stufenlose Einstellung zur Fokussierung des Elektronenstrahls.
TRACE ROTATION	Schraubenziehereinstellung zur Ausrichtung der Schreibspur mit den horizontalen Rasterlinien.

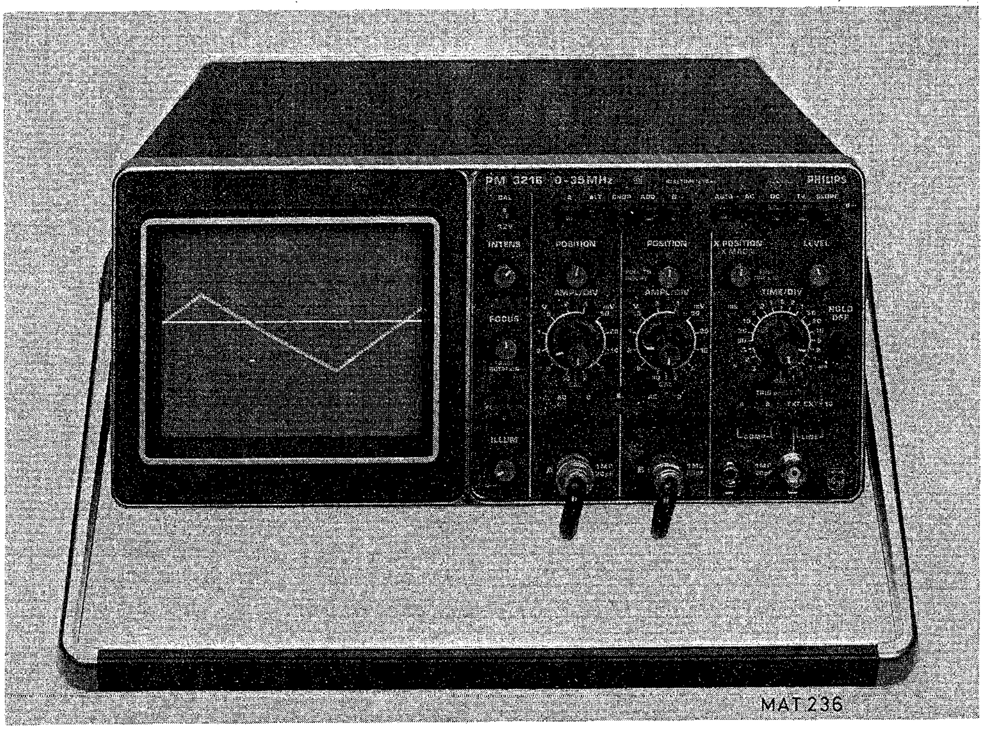


Abb. 2.2. Vorderansicht des Oszillografen mit Bedienungsorganen und Buchsen

2.2.2. Vertikale Kanäle

Darstellungsart-Schalter	*Funktion*
	Fünffacher Druckknopfschalter zur Einstellung der Darstellungsarten. Wird keine Drucktaste betätigt, dann ist Betriebsart ALT eingeschaltet.
A	Vertikalablenkung durch ein an Eingang von Kanal A gelegtes Signal.
ALT	Das Bild wird am Ende jedes Zyklus des Zeitablenksignals von einem Vertikalkanal auf den anderen umgeschaltet.
CHOP	Das Bild wird mit einer Festfrequenz von einem Vertikalkanal auf den anderen umgeschaltet (f ≈ 500 kHz).
ADD	Vertikalablenkung durch die Summe der Signale von Kanal A und B (oder –B).
B	Vertikalablenkung dürch ein an Eingang von Kanal B gelegtes Signal.
POSITION	Stufenlose Einstellung der vertikalen Verschiebung des Bildes.
PULL TO INVERT B	Zug-Druck Schalter kombiniert mit dem POSITION Schalter von Kanal B. Wenn gezogen wird die Kanal B Signalpolarität umgekehrt.
AMPL/DIV (Aussenknopf)	Stufenweise Einstellung der Vertikalablenkkoeffizienten, von 2 mV/div bis zu 10 V/div in 1-2-5 Folge.
AMPL/DIV (Mittelknopf)	Stufenlose Einstellung der Vertikalablenkkoeffizienten. Es ist zu beachten dass der Ablenkkoeffizient nur dann kalibriert ist wenn der Mittelknopf in Stellung CAL (ganz nach rechts) steht.
Eingangskopplungsschalter	Signalkopplung; Zweiweg Druckknopfschalter.
AC (eingedrückt)	Kopplung über einen Sperrkondensator.
DC (ausgelöst)	Direkte Kopplung.
0 (eingedrückt)	Verbindung zwischen Eingangsschaltung und Eingangsbuchse unterbrochen und Eingangsschaltung geerdet.
A	BNC-Buchse für Kanal A Eingang.
B	BNC-Buchse für Kanal B Eingang.

2.2.3. Triggerung

Triggerungsart-Schalter	*Funktion*
	Fünffache Drucktaste zum Einstellen der Triggerungsart und der Polarität der Triggerflanke. Wenn keine der Drucktasten betätigt ist, dann ist Betriebsart AUTO gewählt, und der LEVEL Bereich auf einen festen Wert eingestellt.
AUTO	Ein Bild ist sichtbar auch wenn keine Triggersignale vorhanden sind. Der Bereich der LEVEL-Einstellung ist proportional dem Spitze-Spitze Wert des Triggersignals.
AC	Normale Triggerung und fester Bereich der LEVEL Einstellung. Gleichspannungskomponente des Triggersignals ist gesperrt.
DC	Normale Triggerung und fester Bereich der LEVEL Einstellung. Gleichspannungskomponente des Triggersignals wird durchgelassen.
TV	Zeilen oder Bild Synchronisation je nach Stellung des TIME/DIV Schalters (Bild von .5 s/div bis 50 µs/div und Zeile von 20 µs/div bis .2 µs/div).
+/–	Triggerung auf der positiv oder negativ gerichteten Flanke des Signals. In TV muss "–" für negative Videosignale eingestellt werden und "+" für positive Videosignale.
LEVEL	Stufenlose Einstellung des Signalformpegels bei welchem das Oszillogram startet.
TRIG OR X DEFL	(siehe TRIG OR X DEFL-Quelle Schalter im nachstehenden Abschnitt 2.2.4.).

2.2.4. Horizontaler Kanal

TRIG OR X DEFL-Quelle Funktion Schalter	4-fache Drucktaste zur Wahl der Triggerquelle oder der Horizontalablenkungsquelle wenn der Schalter TIME/DIV in Stellung X DEFL steht. Wenn keine der Drucktasten eingedrückt ist wird Quelle A gewählt.
A	Signal, Kanal A entnommen.
B	Signal, Kanal B entnommen.
COMP (sowohl A wie B eingedrückt; nicht wirksam mit X DEFL)	Signal ist jenem Kanal entnommen, der mit dem elektronischen Schalter durchverbunden ist. Triggerung geschieht mit den am Schirm dargestellten Signalformen.
EXT und EXT ÷ 10	Externes Signal wie an die angrenzende 1 Mohm//20 pF-Buchse gelegt.
LINE	Signal von der Netzspannung (nicht wirksam wenn das Gerät batteriebetrieben ist).
X POSITION X MAGN	Stufenlose Einstellung der horizontalen Lage des Bildes, gekoppelt an einen Zug-Druckschalter für 10-fache Dehnung der Horizontalablenkung.
TIME/DIV (äusserer Teil)	Einstellung des Zeitkoeffizienten von .2 µs/div bis .5 s/div in 1-2-5 Folge. Bestimmt Zeilen- oder Bildtriggerung in TV-Betriebsart. In Stellung X DEFL wird die Horizontalablenkung vom Schalter TRIG OR X DEFL bestimmt.
TIME/DIV (mittlerer Knopf)	Stufenlose Einstellung des Zeitkoeffizienten. Muss in Stellung CAL stehen (d.h. ganz nach rechts) damit die Zeitachse gemäss der Anzeige des Schalters TIME/DIV kalibriert ist.
HOLD OFF (Sperrzeit)	Stufenlose Einstellung der Sperrzeit.

2.2.5. Übrige

CAL	Ausgangsbuchse an der eine Rechteckspannung von ≈ 2 kHz und eine Amplitude von 1,2 V_{s-s} ± 1 % zur Verfügung steht. Für Messkopfkompensation und/oder Prüfung der Vertikalablenkgenauigkeit.
Externe Speisung	Eingangsbuchse an der Rückseite des Geräts gestattet Betrieb mit einer externen Gleichspannung. Speise-Nennspannung 22 V bis 27 V, Stromaufnahmefähigkeit > 1 A.
Netzspannungs-Umschalter	Ist vor dem Anschluss an das örtliche Netz, den in Abschnitt 2.1.2. gegebenen Angaben entsprechend, einzustellen.
Z-mod	Für Z-Achsensteuerung - Siehe Abschnitt 3.6.

2.3. BEDIENUNGSANLEITUNG

2.3.1. Einschalten des Geräts

Vor Anschluss des Geräts an eine Stromquelle sind die in Abschnitt "Inbetriebnahme" gegebenen Anleitungen genauestens auszuführen.

Das Gerät wird normalerweise nach einer Anwärmzeit von etwa 15 Minuten den Spezifikationen (siehe Abschnitt 1.2.) entsprechen. Wenn das Gerät jedoch grosser Kälte ausgesetzt war (z.B. unter Frostbedingungen nachts im Auto gelassen) und danach in einen warmen Raum gebracht wird, ist eine Anwärmzeit von etwa einer halben Stunde einzuhalten (siehe Abschnitt 1.2.8.).

2.3.2. Vorbereitende Einstellungen

Mit diesem Verfahren lässt sich feststellen ob der Oszillograf ordnungsgemäss funktioniert und es ergibt einen tauglichen Ausgangspunkt für den Beginn von Messungen.

Siehe Abb. 2.2. bezüglich der Lage der Bedienungselemente. Bringe die Einsteller INTENS und FOCUS in Mittelstellung. Taste AUTO drücken und mit Schalter TIME/DIV einen durchschnittlichen Zeitkoeffizienten zwischen 10 µs/div und 10 ms/div wählen. Mit allen übrigen Drucktasten in Normalstand (nicht gedrückt) lassen sich die Schreibstrahlspuren von Kanal A und Kanal B mit dem entsprechenden Einsteller POSITION auf dem Bildschirm darstellen.

Mit Bedienungselement INTENS eine mittlere Bildhelligkeit und mit FOCUS eine gute Strahlfokussierung einstellen.

2.3.3. Eingangskopplung (AC/DC, 0)

AC-Kopplung (Drucktaste eingedrückt) dient zum Sperren der Gleichspannungskomponente eines Signals.
Die AC Einstellung unterdrückt die Niederfrequenzen, wodurch sinusförmige Signale niedriger Folgefrequenz abgeschwächt werden und Rechtecksignale niedriger Folgefrequenz verformt werden. Der Abschwächungsgrad wird von der Eingangs RC-Zeit (0,1 s) bestimmt.
Eingangs RC-Zeit wird 10-fach erweitert wenn 10 : 1 passive Messköpfe verwendet werden.
Wenn auf AC-Kopplung geschaltet wird dauert es etwa fünf Eingangs RC-Zeiten bevor der Strahl auf den Mittelwert des Eingangssignals stabilisiert ist.
AC-Stellung Messungen können nicht gegenüber Erde vorgenommen werden.

In **Stellung 0** wird das Eingangssignal unterbrochen und der Verstärkereingang kurzgeschlossen, dies zur Ermittlung des Nullpegels.

DC-Kopplung (Drucktaste normal) ermöglicht Frequenzeingang über den gesamten Bereich, dass heisst bis hinab auf Gleichspannung.

2.3.4. Anwendung von Messköpfen

1 : 1 passive Messköpfe sollten nur für Gleichspannung und Niederfrequenzen eingesetzt werden.
Kapazitive Belastung schwächt hohe Frequenzen ab oder erhöht die Anstiegszeit von Messsignalen (abhängig von Quellimpedanz).
10 : 1 passive Messköpfe besitzen eine kleinere kapazitive Belastung; gewöhnlich etwa 10 pF bis 20 pF.
FET-Messköpfe sind besser, besonders wenn Messungen von Messpunkten mit hoher Impedanz vorgenommen oder an der oberen Frequenzgrenze der Bandbreite des Oszillografen ausgeführt werden sollen.
10 : 1 passive Messköpfe müssen vor Gebrauch ordnungsgemäss kompensiert werden. Ungenaue Kompensation hat Impulsverformung oder Amplitudenfehler bei hohen Frequenzen zur Folge.
Für genaue Einstellung kann der CAL-Ausgangsanschluss verwendet werden (siehe Abb. 2.3.).

2.3.5. Einstellen der Abschwächer-Messköpfe

- Die Kompensationsdose mit Buchse A verbinden und die Messkopfspitze an Buchse CAL legen.
- Einen kleinen Schraubenzieher durch das Loch in der Kompensationsdose einstecken und den Trimmer einstellen, um ein einwandfreies Bild zu erhalten (siehe Abb. 2.3.).

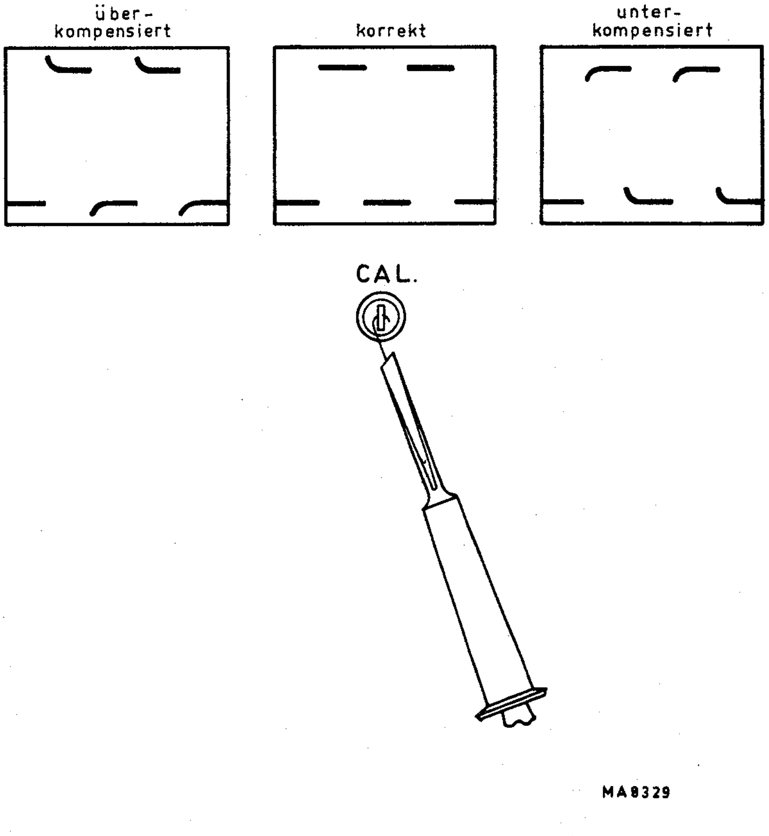


Abb. 2.3. Einstellen des Abschwächer-Messkopfs

2.3.6. Einstellen der gechoppten (CHOP) oder der alternierenden (ALT) Darstellungsart

Im Zweikanalbetrieb (CHOP oder ALT eingedrückt) muss für relative lange Ablenkzeiten (von .1 ms/div bis .5 ms/div) oder bei vorkommender niedriger Ablenk-Folgefrequenz selbst bei kurzen Ablenkzeiten, die Darstellungsart CHOP verwendet werden (CHOP eingedrückt).
Stellung ALT würde unter diesen Umständen Vergleiche zwischen Signalformen erschweren da sonst die beiden Signale gesondert wahrgenommen würden.
Wenn die Darstellung jedoch schnell genug ist um von der Chopperfrequenz unterbrochen zu werden, muss die alternierende Darstellungsart eingestellt werden (ALT eindrücken), gewöhnlich bei Ablenkzeiten schneller als .1 ms/div.

2.3.7. Differentielle Betriebsart

Betriebsart A-B lässt sich durch Drücken von ADD und Ziehen des Knopfes POSITION von Kanal B einstellen.
Bei Messungen wobei Signalleitungen bedeutende Gleichtaktsignale führen (z.B. Brumm) hebt die differentielle Betriebsart diese Signale auf, und lässt den Rest, der von Bedeutung ist, übrig.
Die Fähigkeit des Oszillografen für Unterdrückung von Gleichtaktsignalen ist vom CMR-Faktor gegeben (siehe Abb. 2.4.). Um den spezifizierten Grad der Gleichtaktunterdrückung zu erlangen müssen erst die Kanal A und B Verstärkungen ausgeglichen werden. Dies wird durch Anschluss beider Kanäle an den CAL-Ausgang und durch Einstellung eines der stufenlosen Einstellelemente mit dem Schalter AMPL/DIV auf Minimum-Ablenkung am Bildschirm erreicht.
Bei Verwendung von passiven 10:1 Messköpfen ist ein ähnliches Ausgleichsverfahren zu empfehlen und zwar durch ihre Kompensationseinstellung auf Minimum-Ablenkung zu bringen.

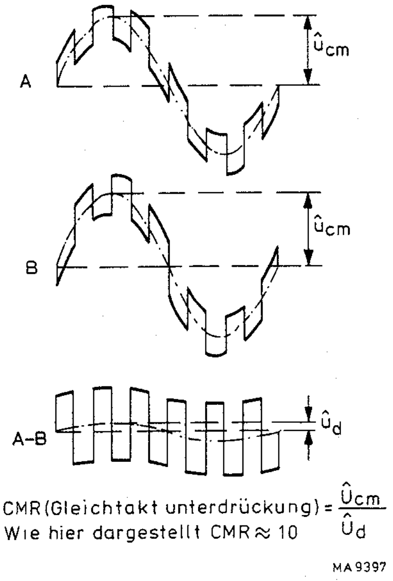

A
$\hat{U}_{cm}$
B
$\hat{U}_{cm}$
A–B
$\hat{U}_d$
CMR (Gleichtakt unterdrückung) = $\frac{\hat{U}_{cm}}{\hat{U}_d}$
Wie hier dargestellt CMR ≈ 10
MA 9397

Abb. 2.4. Gleichtaktunterdrückung

2.3.8. Einstellen der Triggerart

(AUTO AC DC TV +/–)

Betriebsart AUTO ist äusserst nützlich, da dabei das Bild stets sichtbar ist, auch wenn keine Triggersignale vorhanden sind. Ausserdem bewirkt diese Betriebsart für eine Signalamplitude die grösser ist als ein Teil (div.) eine stabile Triggerung unabhängig von der Stellung des Pegeleinstellers LEVEL; ihr Bereich wird automatisch auf den Spitze-Spitzewert des für Triggerung gewählten Signals eingestellt.
Auf diese Weise wird die LEVEL-Einstellung bei kleinen Amplituden des Triggersignals erleichtert.
Betriebsart AUTO lässt sich für Signale mit niedriger Folgefrequenz (10 Hz oder niedriger) nicht verwenden weil dies freilaufende Ablenkung zwischen Triggerimpulsen ermöglichen würde. Deshalb ist bei Signalen niedriger Folgefrequenz die normale Triggerung anzuwenden (AC oder DC gedrückt).
Bei normaler Triggerung wird die Zeitablenkung nur dann ausgelöst wenn ein Triggersignal angelegt wird und LEVEL entsprechend eingestellt ist.
Mit gedrücktem AC oder DC ist der Bereich des Einstellers LEVEL festgesetzt (+ oder –8 Teile (div.) oder mehr in den äussersten Stellungen von LEVEL, bezogen auf die Bildschirmmitte).
Die Gleichspannungskomponente des Triggersignals lässt sich durch Eindrücken von AC sperren.

Dies ist nützlich wenn bei einem Wechselspannungsignal das einem hohen Gleichspannungspegel überlagert ist getriggert werden soll. Bei AC-Kopplung verändert der Pegel bei welchem die Darstellung beginnt mit Änderungen im Mittelwert des Triggersignals. Der Triggerpegel ist nicht auf Signalerde bezogen. Dies kann bei Signalformen die im Zeitabstand von Zyklus zu Zyklus variieren Instabilität zur Folge haben. Normalerweise ist Anwendung der DC-Stellung vorzuziehen. Flankenwahl ist mit Drucktaste +/– vorzunehmen. Bei Betriebsart TV ist für negative Videosignale "–" einzustellen und "+" für positive Videosignale. Einsteller LEVEL ist bei Betriebsart TV nicht wirksam. Eine zusätzliche Anwendungsweise wird geboten wenn keine Tasten eingedrückt sind, eine Zeitablenklinie ist am Bildschirm sichtbar während kein Triggersignal vorhanden ist, und der Pegelbereich des Einstellers LEVEL fest ist.

2.3.9. Triggerquelle

Die Triggerquelle wird mit den Frontplatte-Drucktasten TRIG or X DEFL eingestellt.

A B EXT EXT ÷ 10
└ COMP ┘ └ LINE ┘

- **Interne Triggerung** ist die im allgemeinen meist angewandte, da sie nur ein Signal erfordert (das Eingangssignal) um stabile Triggerung zu erlangen.
- **Externe Triggerung.** Falls mehrere Signale abgetastet werden, ist es günstig ein externes Signal zur Trigerung zu benutzen. Bei einer Änderung des Eingangssignals ist Einstellung und Neueinstellung der Trigger-Bedienungselemente (LEVEL, SLOPE und SOURCE) nicht nötig. Ausserdem bleiben die beiden Eingängen A und B für Untersuchungen der Signalformen verfügbar.
- **Wahl der Triggerquelle.** Bei Vergleichung synchroner Signalformen mit ungleicher Folgefrequenz immer das Signal mit der niedrigsten Folgefrequenz als Triggersignal wählen. Wenn nicht, könnten Doppelbilder (gechopped) oder falsche Zeitverschiebungen (alternierend) entstehen.
- **Zusammengesetzte (composite) Triggerung.** Bei interner Triggerung werden Triggersignale von entweder dem A-Kanal, den B-Kanal Vorverstärkerstufen oder wenn in Stellung COMP durch Eindrücken der beiden Tasten A und B, von der Verzögerungsleitungs-Treiberstufe die dem elektronischen Kanalschalter folgt, erhalten.

  Zusammengesetztc Triggerung bietet drei Vorteile:

  1. In der differentiellen Betriebsart (A-B Messungen) wird die Triggerung vom Differenzsignal ausgelöst. Die Triggerung wird nicht von Gleichtaktsignalen gestört.
  2. Für Einkanal-Betrieb ist es nicht nötig Triggerquellen von A nach B oder umgekehrt zu schalten.
  3. In alternierender Betriebsart lassen sich Signale vergleichen, die nicht in zeitlicher Beziehung stehen.

  Bemerkung: Bei Anwendung zusammengesetzter Triggerung in Zweikanalbetrieb (alternierend) und wenn dabei nur ein Signal angelegt ist (an Eingang A oder B), ist stabile Triggerung nicht erlangbar. Das ist nicht ungewöhnlich, da die Triggerquelle auch von A nach B geschaltet wird (siehe Abb. 2.5.).

- **Netztriggerung** von der 50 Hz Netzspeisung ist nützlich wenn der Signaleingang Netzfrequenz bezogen ist. Bei Anwendung zusammengesetzter Triggerung in Zweikanalbetrieb (gechopped) ist stabile Triggerung nicht möglich, weil das System von den Vorübergehenden Spitzen der Choppersignale getriggert wird.

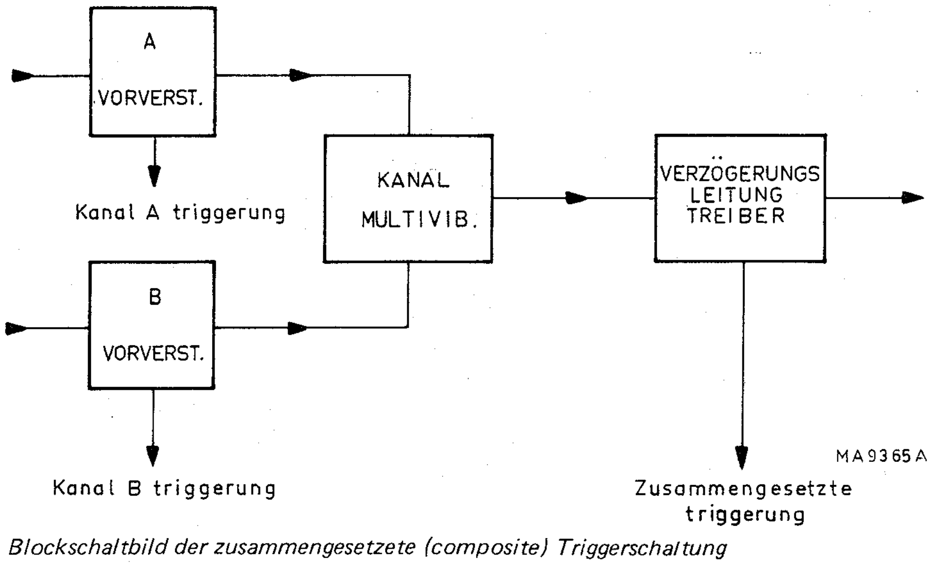


Abb. 2.5. Blockschaltbild der zusammengesetzete (composite) Triggerschaltung

2.3.10. Dehnung der Zeitablenkung

Die Dehnung wird durch Ziehen des an Steller X POSITION gekoppelten Schalters X MAGN bewirkt. Mit diesem Schalter in Stellung x10 wird die Zeitablenkgeschwindigkeit 10 fach vergrössert. Die Ablenkzeit wird daher durch Teilung des angezeigten Wertes TIME/DIV durch 10 bestimmt. .

2.3.11. Einstellen der Sperrzeit

Diese Einstellung wird benutzt zur Steigerung der Sperrzeit.

2.3.12. XY Messungen

Für XY Messungen steht der Schalter TIME/DIV auf EXT X DEFL, die Quelle der Horizontalablenkung wird mit Drucktaste TRIG oder X DEFL (A, B, EXT, EXT ÷ 10 oder LINE) eingestellt.

XY Messungen ergeben ein zweckmässiges Mittel für Frequenz- oder Phasenverschiebungsvergleiche durch Darstellung mit Lissajous Figuren. Messungen bis zu 100 kHz sind möglich, wobei der Phasenfehler zwischen den horizontalen und vertikalen Oszillografenkanälen geringer als 3^{o} ist.

Nachstehende Tabelle zeigt die Empfindlichkeit der verschiedenen XY-Betriebsarten.

X Ablenkung	Empfindlichkeit
A	AMPL/DIV A ± 10%
B	AMPL/DIV B ± 10%
EXT	0,2 V/DIV
EXT ÷ 10	2 V/DIV
LINE	8 Teile (divisions)

2.4. VERFAHREN ZUM ENTFERNEN VON SICHERUNGEN, BILDRÖHRENRAHMEN UND KONTRASTPLATTE

2.4.1. Abnehmen der Abdeckhauben

Es ist immer darauf zu achten, dass vor Abnahme irgendwelcher Deckel oder Platten das Gerät vom Netz getrennt ist.

Das Gerät ist durch drei Abdeckhauben geschützt: eine Frontschutzhaube, ein Mantel mit Tragbügel und eine Abdeckplatte für die Rückwand.

Die Frontschutzhaube muss erst angebracht werden, dies erleichtert Abnahme des Mantels und der Rückwandplatte.

Das Abnehmen geschieht wie folgt:

- Den Tragbügel von der Frontplatte wegschwenken, zu diesem Zweck die beiden Drehzapfenknöpfe drücken (Abb. 2.6.).
- Das Gerät auf seiner Frontschutzhaube auf eine ebene Fläche stellen.
- Die beiden Schlitzschrauben auf der rückwärtigen Abdeckplatte lösen.
- Die rückwärtige Abdeckplatte abheben und den Stecker aus der Netzteil-Leiterplatte ziehen.
- Den Mantel abnehmen.
- Die Frontplatte wird zugänglich, wenn das Gerät horizontal aufgestellt wird und die Frontschutzhaube abgezogen wird.

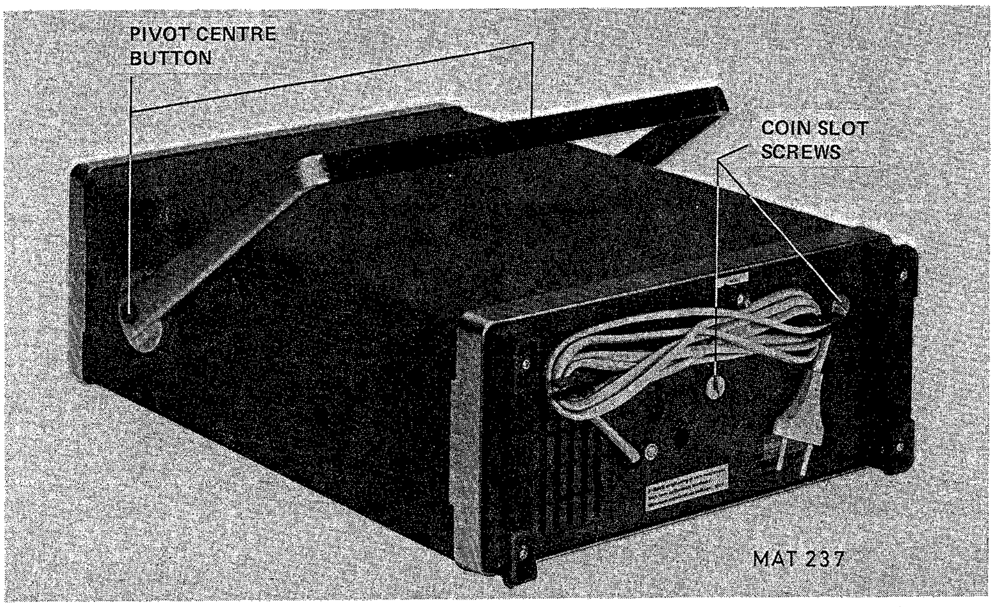


Abb. 2.6. Abnehmen der Gerätabdeckhauben und des Tragbügels.

2.4.2. Ausbau des Netztransformators

- Gerätemantel und Rückwand abnehmen (Abschnitt 2.4.1.).
- Nach Lösen der 4 Kreuzschlitzschrauben den Deckel des Spannungsadapterfachs abnehmen.
- Die vier Kreuzschlitzschrauben mit denen der Deckel des Transformatorfachs befestigt ist lösen.
- Den Deckel mit dem daran befestigten Transformator abheben und gleichzeitig den Draht zwischen Transformator und Spannungsadapter aus dem Schlitz im Transformatorfach schieben.
- Transformator und Schmelzsicherung sind nun zugänglich und können ersetzt werden.

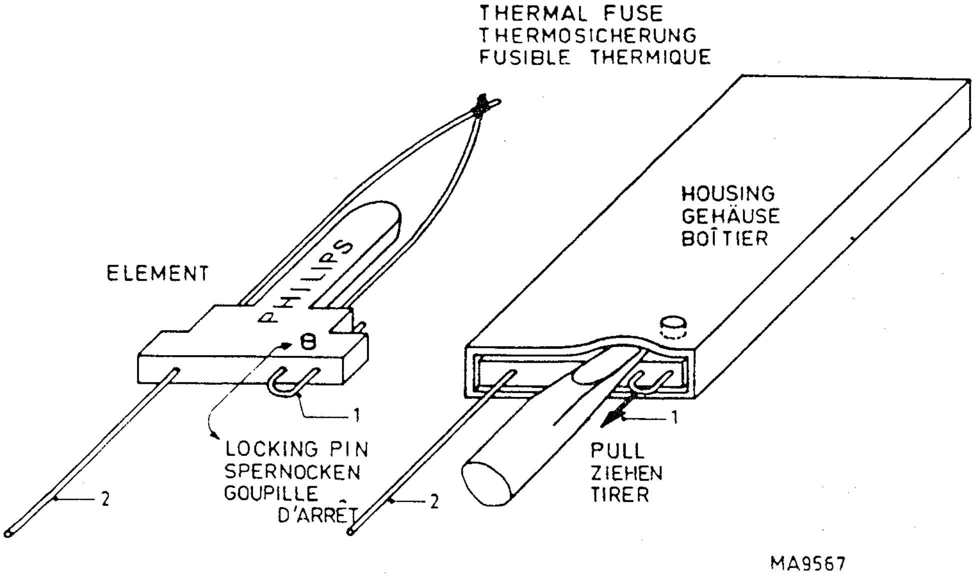

THERMAL FUSE
THERMOSICHERUNG
FUSIBLE THERMIQUE
HOUSING
GEHÄUSE
BOÎTIER
ELEMENT
PHILIPS
1
2
LOCKING PIN
SPERNOCKEN
GOUPILLE D'ARRÊT
2
1
PULL
ZIEHEN
TIRER
MA9567

Abb. 2.7. Ersetzen der Schmelzsicherung

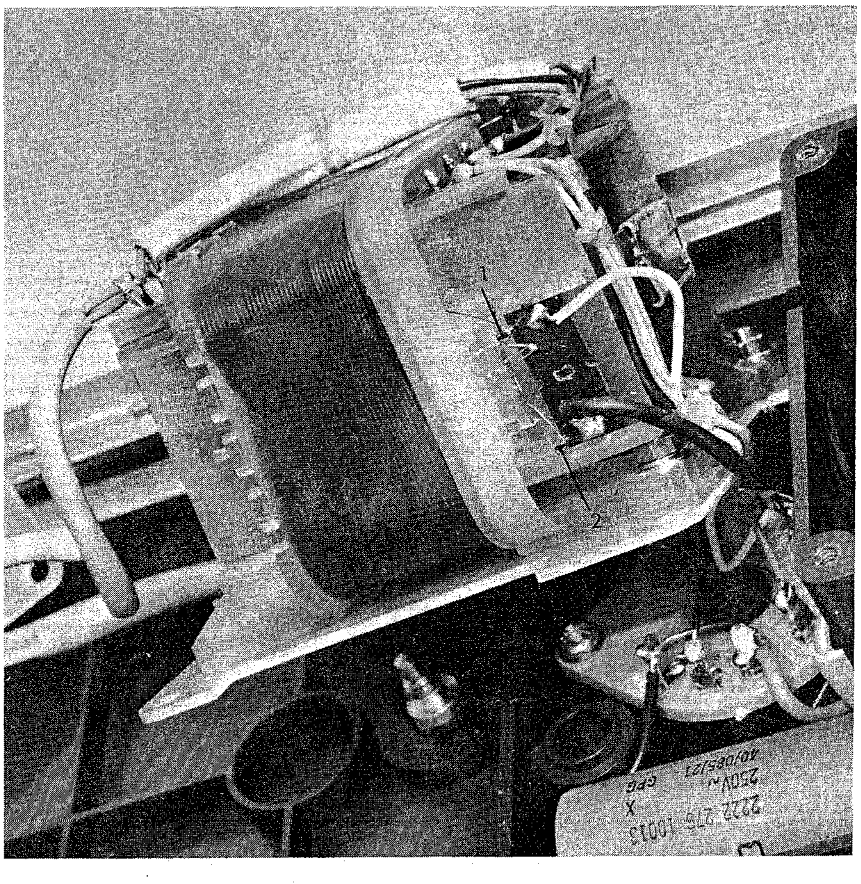


Abb. 2.8. Ersetzen der Schmelzsicherung

2.4.3. Ersetzen der Schmelzsicherung F101

- Netztransformator entfernen (Abschnitt 2.4.2.).
- Sicherungsanschlussdrähte 1 und 2 ablöten (Abb. 2.7. und 2.8.).
- Es wird nur der Sicherungsdraht der alten Sicherung ersetzt und nicht die gesamte Sicherung; zu diesem Zweck das Gehäuse der Sicherung etwas nach aussen biegen, die Sperrnocken freilegen und den Draht herausziehen.
- Die neue Sicherung nehmen und den Sicherungsdraht auf die gleiche Weise wie oben beschrieben aus seinem Gehäuse ziehen.
- Den neuen Sicherungsdraht in das Gehäuse der alten Sicherung stecken bis die Sperrnocken im Loch einschnappen. Die Schleife im Sicherungsdraht muss nach Anschluss 1 gerichtet sein.
- Die Sicherungsdrähte an Anschlüsse 1 und 2 löten.

2.4.4. Ersetzen der Sicherung F201

- Gerätemantel und Rückwand abnehmen (Abschnitt 2.4.1.).
- Die sich auf der Netzteil-Leiterplatte befindliche Sicherung F201 ist nun zugänglich und kann ersetzt werden.

2.4.5. Abnehmen des Bildröhrenrahmens und der Kontrastplatte

- Den Bildröhrenrahmen an den unteren Ecken festhalten und vorsichtig von der Frontplatte ziehen. (Abb. 2.9.).
- Die Kontrastplatte kann nun behutsam aus dem Rahmen gedrückt werden.

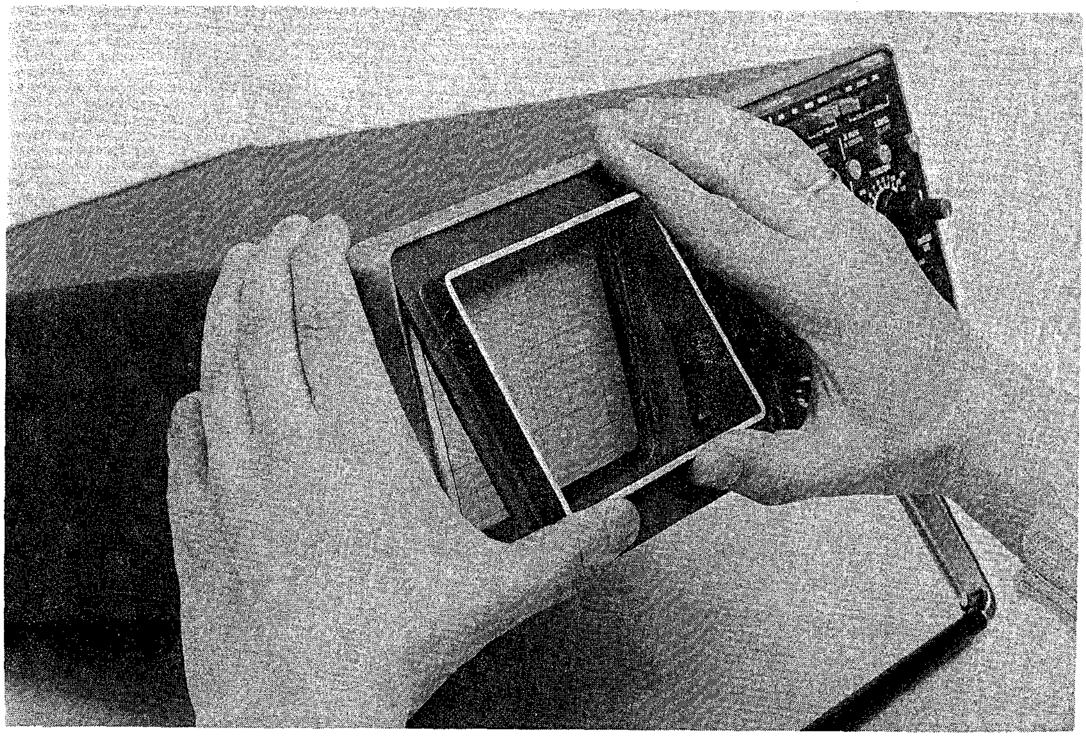


Abb. 2.9. Abnehmen des Bildröhrenrahmens und der Kontrastplatte.

1. Généralités

1.1. INTRODUCTION

L'oscilloscope 35 MHz à double trace PM 3216 est un instrument compact et léger, de conception ergonomique et à possibilités de mesure étendues.
Un écran de 8 x 10 cm, à graticule interne, une trace de forte intensité et des caractéristiques telles que le déclenchement TV, des modes de déclenchement commutables et des modes d'addition pour la voie verticale, rendent cet instrument approprié à une large gamme d'applications.
Une alimentation à double isolement permet de connecter le châssis directement à des circuits de terre flottants, à condition qu'ils ne présentent pas de tension dangereuse au toucher.
De plus, il y a réduction substantielle du parasitage par les courants de terre, dont sont fréquemment affectés les oscilloscopes mis à terre.
L'emploi de l'oscilloscope à pied d'oeuvre est facilité par la possibilités du fonctionnement sur batterie.

ATTENTION: **La masse du châssis (et le câble de masse de sonde), ne doivent pas être connectés à des circuits sous tension dangereuse au toucher.**

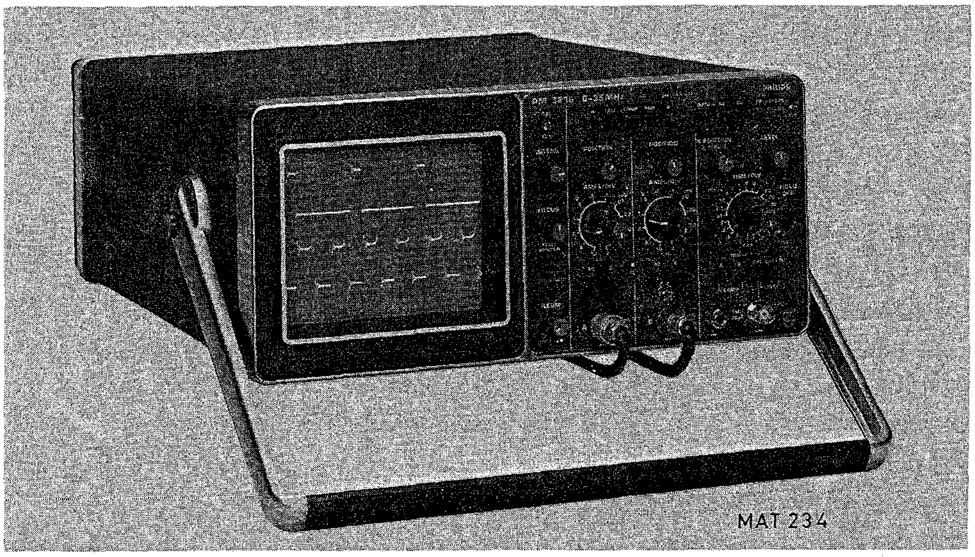


Fig. 1.1. Oscilloscope 35 MHz à double trace PM 3216

1.2. CARACTERISTIQUES

Cet appareil a été conçu et testé conformément à la norme C.E.I. 348 pour appareils de classe II. A sa livraison il répond aux règles de sécurité. La présente notice comporte les informations et les avertissements nécessaires à l'utilisateur afin d'assurer le fonctionnement de l'appareil dans les conditions de sécurité et de le maintenir conforme à la norme.

Sauf indications contraires, les propriétés exprimées en valeurs numériques tolérancées sont garanties pour des températures ambiantes comprises entre +5°C et +40°C et un temps de chauffage de 30 minutes. Les valeurs numériques non tolérancées sont des valeurs normales et représentent les caractéristiques d'un instrument moyen.

	Désignation	*Spécification*	*Renseignements supplémentaires*
1.2.1.	**Tube cathodique**		
	Type	D14 - 125 GH/08	
	Surface utile de l'écran	8 x 10 divisions	1 division égale 1 cm
	Type d'écran	P31 (GH)	P7 (GM) en option
	Tension totale d'accélération	10 kV	
	Graticule	Interne	Réglage continu de l'éclairement
1.2.2.	**Amplificateur vertical**		
	Modes d'affichage	Voie A seulement Voie B seulement A et B commutées A et B alternées A et B ajoutées	
	Polarité de la voie B	Normale ou inversée	
	Réponse:		
	Bande passante	DC : 0 Hz ... ⩾ 35 MHz (–3 dB) AC : 2 Hz ... ⩾ 35 MHz (–3 dB)	
	Temps de montée	⩽ 10 ns	
	Précision de mesure	⩽ ± 3% (⩽ 4% c.c.)	Mesurée pour une amplitude de 6 divisions et un temps de montée ⩾ 1 ns
	Coefficients de déviation	2 mV/div ... 10 V/div	Progression 1-2-5
	Plage de réglage continu	1 : ⩾ 2,5	
	Précision de déviation	± 3 %	
	Impédance d'entrée	1 MΩ//20 pF	
	Temps d'entrée RC	0,1 s	Couplage capacitif
	Tension maximale admissible d'entrée	400 V	Tension continue + tension alternative crête
	Fréquence de commutation	≈ 500 kHz	
	Décadrage vertical	16 divisions	
	Gamme dynamique	24 divisions	
	Retard de signal visible	⩾ 2 divisions	A 10 ns
	Facteur de réjection en mode commun	⩾ 40 dB à 1 MHz	Après réglage en continu ou sur basses fréquences
	Diaphonie entre voies	–40 dB ou mieux ä 10 MHz	Les deux atténuateurs dans le même position
	Instabilité de la position du spot:		
	Dérive de température	⩽ 0,3 div/heure	

1.2.3. Base the temps

Vitesses de balayage	0,5 s/div ... 0,1 µs/div	Progression 1-2-5
Gamme de réglage continue	1 : ≥ 2,5	
Précision	± 3%	
Agrandissement	10x	
Erreur d'agrandissement	± 2%	
Coefficient de temps efficace maximal	10 ns/div	

1.2.4. Déclenchement

Source	Voie A, voie B, composite, externe, externe ÷ 10 et fréquence secteur	
Mode de déclenchement	Automatique, normal alternatif, normal continu et TV	TV ligne ou trame choisi à l'aide du commutateur TIME/DIV TV trame: 50 µs/div – .5 s/div TV ligne: 0,2 µs/div – 20 µs/div
Sensibilité de déclenchment	Interne: 1,0 div à 35 MHz Externe: 0,2 Vcc à 35 MHz Externe ÷ 10: 2 Vcc à 35 MHz	
	TV int.: 0,7 div TV ext.: 0,35 Vcc	Amplitude de l'impulsion de synchronisation
Gamme de fréquence de déclenchement	AUTO: 20 Hz ... ≥ 35 MHz AC: 5 Hz ... ≥ 35 MHz DC: 0 Hz ... ≥ 35 MHz	Un déclenchement stable peut être obtenu à 50 MHz et à une amplitude de 2 div ou 1 Vcc (caractéristique moyen)
Gamme de niveau	AUTO: proportionelle à la valeur crête à crête du signal de déclenchement DC, AC:	
	16 div en déclenchement interne	+ ou –8 div et
	3,2V en déclenchement externe et	+ ou – 1,6V par rapport au centre de l'écran
	32V en déclenchement externe ÷ 10	+ ou – 16V par rapport au centre de l'écran
Pente	+ ou –	
Impédance d'entrée	1 MΩ//20 pF	
Tension maximale d'entrée	400 V	Tension continue + tension alternative crête (moins de 100 kHz)
Temps de blocage (Hold-off)	Variable	

1.2.5. Déviation X

Source	A,B,EXT,EXT ÷ 10 ou LINE (MAINS)	En fonction de la position du commutateur de source de déclenchement, si le commutateur TIME/DIV est en position X DEFL.
Coefficients de déviation	A, ou B: suivant la position de AMPL/DIV EXTERNAL: 0,2 V/div EXT ÷ 10: 2 V/div. LINE: 8 divisions	
Précision	± 10% en A ou B	
Gamme de fréquence	Couplage direct: 0 ... 1 MHz (–3 dB) Couplage capacitif: 5 Hz ... 1 MHz (–3 dB)	
Déphasage	≤ 3° à 100 kHz	
Gamme dynamique	24 divisions	Pour fréquences ≤ 100 kHz

1.2.6. Générateur d'étalonnage

Tension de sortie	1,2 Vcc	Onde carrée
Précision	± 1%	
Fréquence	≈ 2 kHz	

1.2.7. Alimentation

Alimentation alternative:	à double isolement	Classe de sécurité II, IEC 348
Tensions nominales (sur le carrousel)	110, 127, 220 ou 240 V cc ± 10 %	
Gamme de fréquence nominale	50 ... 400 Hz ± 10 %	
Consommation	28 W maxi	A la tension secteur nominale
Alimentation continue:		
Gamme de tension	22-27 V continu	Entrée flottante
	20-28 V continu	A des conditions moins strictes
Consommation	1,1 A maxi	
Capacité à la terre	110 pF	Mesurée avec pied caoutchouc sur plaque métallique de 1 m^2 mise à la terre
	23 pF	Mesurée 30 cm au-dessus de la plaque de 1 m^2 à la terre

1.2.8. Conditions ambiantes

Les données d'environnement ne sont valables que si l'instrument est contrôlé conformément aux méthodes officielles. Des renseignements sur ces méthodes et sur les critères employés sont fournis sur demande par l'organisation PHILIPS de votre pays ou par le TEST AND MEASURING DEPARTMENT de la N.V. PHILIPS' GLOEILAMPENFABRIEKEN à EINDHOVEN, PAYS-BAS.

Température ambiante:		
Gamme de référence d'utilisation	+5 $^{\circ}$C ... +40 $^{\circ}$C	
Gamme limite d'utilisation	–10 $^{\circ}$C ... +55 $^{\circ}$C	
Conditions de stockage et de transport	–40 $^{\circ}$C ... +70 $^{\circ}$C	
Humidité	Suivant IEC 68 Db	
Chocs	1000 chocs de 10 g, 1/2 sinus, d'une durée de 6 ms dans chacune des 3 directions	
Essais de vibration	30 minutes dans chacune des 3 directions, 10-150 Hz; amplitude 0,7 mm$_{c.c.}$ et 5 g accélération maxi	
Altitude maximum:		
Limite opérationelle	5000 m (475 m bars) (= 4,75 K Pa)	à l'air libre
Limite de transport	15000 m (100 m bars) (= 10 K Pa)	
Temps de rétablissement	30 minutes si la température de l'instrument passe de –10 $^{\circ}$C à +20 $^{\circ}$C sous humidité relative de 60 %	
Interférence électromagnétique	Conforme à VDE Störgrad K	

1.2.9. Caractéristiques mécaniques

Dimensions:		
Longueur	445 mm	Poignée et commandes non comprises
Largeur	300 mm	Poignée non comprise
Hauteur	137 mm	Pied non compris
Poids	7,9 kg	

1.2.10. Entrée modulation -Z et 2 sorties supplementaires possibles

Pour specifications voir chapitre 3.6.

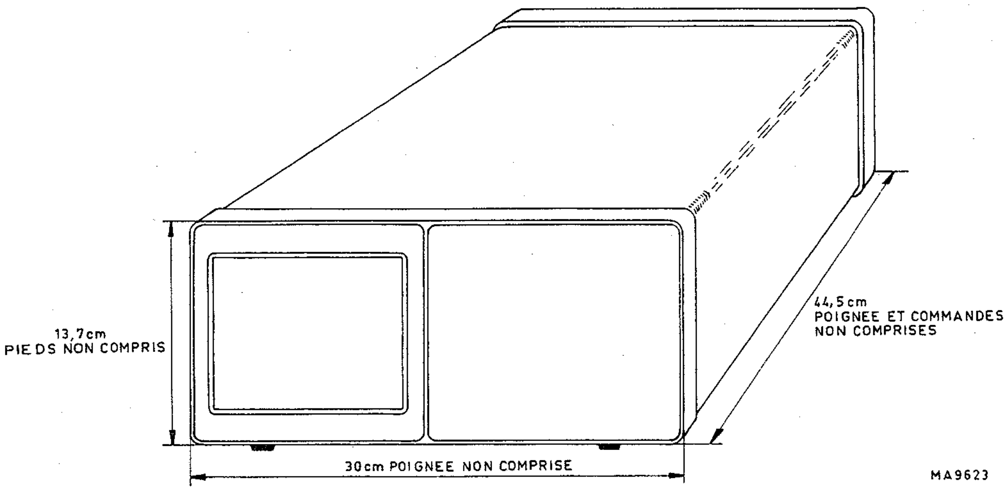

13,7cm
PIEDS NON COMPRIS
44,5cm
POIGNEE ET COMMANDES
NON COMPRISES
30cm POIGNEE NON COMPRISE
MA9623

Fig. 1.2. Dimensions

1.3. ACCESSOIRES

1.3.1. Fournis avec l'instrument

Couvercle avant
2 Adaptateur BNC 4 mm
2 Sondes
Notice d'emploi et d'entretien

1.3.2. En option

PM 8925	Sonde passive 10:1 (1,5 m) 40 MHz
PM 8925L	Sonde passive 10:1 (2,5 m) 40 MHz
PM 8921	Sonde passive 1:1 (1,5 m) 15 MHz
PM 8921L	Sonde passive 1:1 (2,5 m) 15 MHz
PM 8940	Amplificateur d'isolation
PM 8943	1:1, 1:10, 1:100 650 MHz sonde active à FET
PM 9355	Sonde de courant
PM 8910	Filtre Polaroid
PM 9380	Caméra d'enregistrement
PM 8971	Adaptateur pour PM 9380
PM 8962	Adaptateur pour montage en rack 19"
PM 9366	Visière repliable
PM 8980	Visière longue
PM 8901	Batteries rechargeables 330 V continues/24 V continue
PM 8991	Table roulante
PM 8992/01	Malette pour accessoires
Jeu d'outils d'ajustage	

Voir également chapitre 3.5. "INFORMATION CONCERNING ACCESSORIES".

1.4. DESCRIPTION DU SCHEMA SYNOPTIQUE (voir figure 1.3., page 14)

1.4.1. Voie Y

Les voies verticales A et B pour signaux à représenter sont identiques; elles comprennent chacune un commutateur de couplage d'entrée, un atténuateur d'entrée, un convertisseur d'impédance et un préamplificateur avec étage sélectif de déclenchement.

Un multivibrateur de voies, commandé par les bouton-poussoirs de mode de représentation, commute soit la voie A soit la voie B à l'amplificateur Y de sortie par l'intermédiaire de la ligne à retard.

Ce multivibrateur est piloté par une impulsion en fin de balayage et offre une représentation ininterrompue des formes d'onde A et B en mode ALT. En mode CHOP le multivibrateur fonctionne librement et fournit une représentation découpée des deux signaux. En position ADD, les deux amplificateurs de commutation connectent les deux signaux, ils additionnent les voies A et B. Lorsqu'on inverse l'amplificateur de voie B (PULL TO INVERT B), on obtient le mode A-B.

Les commutateurs AMPL/DIV donnent la commande de gain x1 ou x10 du préamplificateur, offrant avec l'atténuateur une gamme complète des coefficients de déviation dans une progression 1-2-5.

1.4.2. Déclenchement

Pour démarrer des balayages, des signaux de déclenchement peuvent être dérivés des préamplificateurs de voie verticale A et B, d'une source externe ou de façon interne de l'alimentation (déclenchement LINE) comme sélectionné à l'aide du commutateur de source de déclenchement.

Lorsque les boutons-poussoirs A et B sont enfoncés, le déclenchement composite est dérivé de l'étage de commande pour la ligne à retard.

La polarité du signal de déclenchement (négatif ou positif) auquel l'affichage est démarré, est déterminé en modifiant la polarité de sortie du convertisseur d'impédance.

Lorsque le commutateur AUTO est enfoncé, le détecteur de niveau crête-à-crête est mis en service. Le niveau crête-à-crête du signal détermine alors la gamme de commande LEVEL.

Lorsque AC ou DC est enfoncé, la gamme de la commande LEVEL est fixe.

En mode TV, la commande LEVEL n'est pas en service et le séparateur de synchronisation TV est mis en circuit, ce qui démarre les balayages avec impulsions de ligne ou de trame en fonction de la position du commutateur TIME/DIV.

1.4.3. Circuit de base de temps

En fonctionnement normal interne, l'amplificateur horizontal reçoit des balayages du circuit de base de temps.

Lorsque AUTO est enfoncé et en l'absence de signaux de déclenchement, la sortie du générateur de balayage est retournée à son entrée par l'intermédiaire du circuit de blocage et de la porte. Les balayages sont alors libres et une trace résultante est représentée sur l'écran. Dès que le circuit de commande AUTO détecte un déclenchement (par ex. changement à la sortie du circuit logique de déverrouillage), le balayage est retourné au circuit logique de déverrouillage.

Le circuit repasse alors en mode de déclenchement normal, c à d que les balayages ne sont démarrés que par des impulsions de déclenchement à l'entrée du circuit logique de déverrouillage.

Lorsque AC ou DC est enfoncé, la commande AUTO est mise hors service.

Des balayages ne sont produits que si un signal de déclenchement est présent et que la commande LEVEL est adéquatement réglée.

L'affichage peut être agrandi en sens horizontal en accentuant le gain de l'amplificateur de sortie.

En position EXT du commutateur TIME/DIV, la sortie du générateur de balayage vers l'amplificateur de sortie est bloquée et le convertisseur d'impédance directement connecté à l'amplificateur de sortie. De cette façon, les signaux normalement sélectionnés pour le déclenchement ou une source externe peuvent servir à la déviation horizontale.

1.4.4. Circuit de blocage

L'étage de blocage bloque les déclenchements provenant de l'entrée du circuit de base de temps, jusqu'à ce que la trace soit entièrement retournée et que les circuits de base de temps soient remis à zéro. Une commande est utilisée pour augmenter le temps de blocage du balayage.

1.4.5. Axe Z

L'amplificateur Z sert à supprimer la trace pendant le retour du spot et le temps de blocage, De plus, il supprime le balayage en mode CHOP pendant les phénomènes transitoires de commutation. La trace supprimation est aussi possible d'un signal connecter à la douille pour modulation Z-externe. Les composants basse fréquence du signal de suppression sont modulés et démodulés avant d'être appliqués au cylindre Wehnelt en même temps que les composants haute fréquence couplés en alternatif.

1.4.6. Alimentation

L'alimentation secteur (réseau) est transformée et rectifiée avant d'être appliquée au régulateur continu-alternatif.

Lorsque l'appareil est actionné par batteries, la sortie de batterie est directement connectée au régulateur continu-alternatif.

La sortie du régulateur est couplée à un transformateur et à un rectificateur. Après la rectification, celui-ci fournit le potentiel de tension extrêmement élevé de —1,5 kV et les tensions d'alimentation du circuit.

Le —1,5 kV est multiplié à 8,5 kV afin de fournir la tension d'accélération totale requise de 10 kV environ.

2. Mode d'emploi

2.1. INSTALLATION

2.1.1. Règlements de sécurité (conformes à la IEC 348)

Avant de brancher l'instrument sur le secteur, examiner le coffret, les commandes, les connecteurs, etc. pour s'assurer qu'il n'y a pas eu de dommages en cours de transport. Si l'on constate des défauts, ne pas brancher l'instrument.

Il faut déconnecter l'instrument de toute source de tension et décharger les points sous haute tension avant d'effectuer aucun travail d'entretien ou de réparation. Si les réglages ou l'entretien ne peuvent se faire autrement que sur l'instrument en marche, couvercles déposés, le travail devra être confié à un spécialiste conscient des risques encourus. L'alimentation étant à double isolement, il n'est pas nécessaire de mettre l'appareil à la terre en fonctionnement normal.

ATTENTION: **Il ne faut pas oublier qu'en cours de fonctionnement la masse du châssis de l'oscilloscope. est portée au même potentiel que la connexion de terre de la sonde de mesure.**
Ni le câble de masse de la sonde, ni le châssis ne doivent être connectés à des sources de tension dangereuse au toucher.

2.1.2. Branchement sur le secteur et fusibles

Avant de brancher l'appareil sur le secteur, s'assurer qu'il est réglé sur la tension correcte. A sa livraison, l'instrument est réglé sur 220 V. S'il doit être utilisé sur du 110 V, 127 V ou 220 V, il faut l'adapter en modifiant la position du carrousel sur le panneau arrière (voir figure 2.1.).

L'instrument est protégé contre les surcharges par un fusible thermique monté entre les enroulements du transformateur secteur. Pour remplacer le fusible, il faut déposer le panneau arrière de l'instrument (voir section 2.4.).

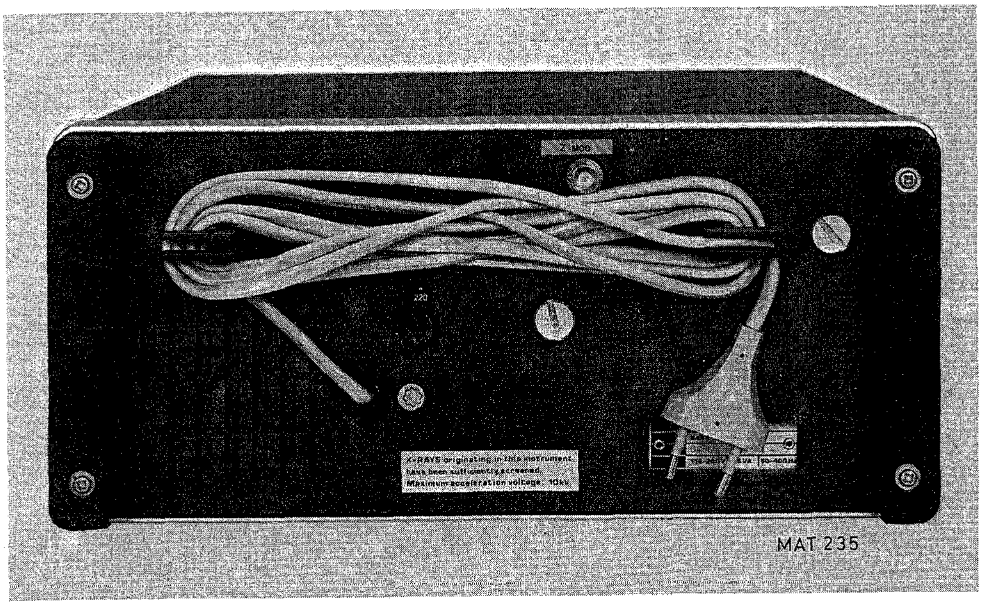

Z MOD
220
X-RAYS originating in this instrument
have been sufficiently screened.
Maximum acceleration voltage: 10kV
MAT 235

Fig. 2.1. Vue arrière de l'oscilloscope avec carrousel en position 220 V

2.1.3. Branchement sur une alimentation extérieure

On peut connecter une alimentation extérieure ou batterie de 22 à 27 V, capable de fournir au moins 1 A, sur la prise du panneau arrière (câble pourvu d'une fiche: 4822 321 20125).
Le conducteur intérieur doit être connecté au pôle négatif, le conducteur extérieur au pôle positif, comme indiqué sur le panneau arrière.
L'instrument est protégé contre les surcharges et contre le changement de polarité par une diode et un fusible internes. Pour remplacer le fusible, il faut déposer le panneau arrière de l'instrument (voir section 2.4.).

2.1.4. Couvercle avant et position de l'instrument

Pour enlever le couvercle avant, il suffit de le tirer vers soi. On peut employer l'instrument en position horizontale ou sous plusieurs inclinaisons en se servant de la poignée de transport comme support.
Pour déverrouiller la poignée, enfoncer simultanément les deux boutons de pivotement centraux.

2.2. COMMANDES ET PRISES

Voir la figure 2.2.

2.2.1. Tube cathodique et commandes de puissance

ILLUM POWER ON	Bouton de réglage continu de l'éclairement du graticule; comprend l'interrupteur secteur. La veilleuse indique l'état en circuit.
INTENS	Réglage continu de la brillance de la trace.
FOCUS	Réglage continu de la focalisation du faisceau électronique.
TRACE ROTATION	Réglage par tournevis de l'alignement de la trace sur les lignes horizontales du graticule.

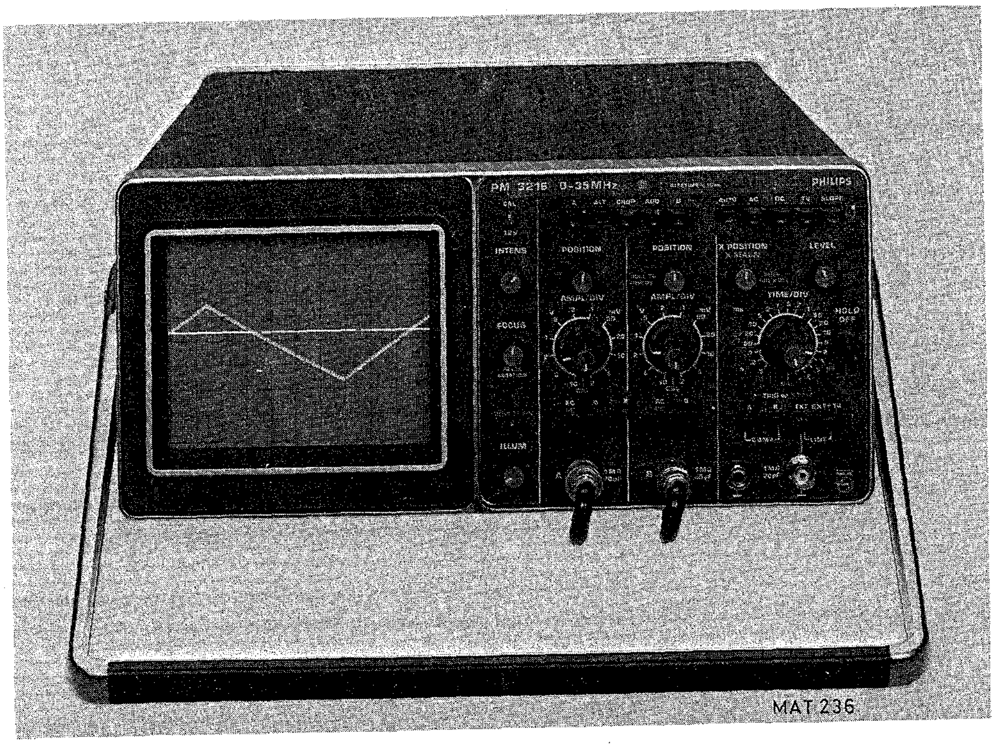


Fig. 2.2. Vue avant de l'oscilloscope montrant les commandes et douilles

2.2.2. Déviation verticale

Commutateur de mode d'affichage	*Fonction* 5 boutons-poussoirs pour sélection du mode d'affichage verticale. Si aucun bouton n'est enfoncé, l'oscilloscope fonctionne en mode ALT.
A	La déviation verticale est commandée par le signal connecté à l'entrée de la voie A.
ALT	L'affichage passe d'une voie à l'autre à la fin de chaque cycle du signal de base de temps.
CHOP	L'affichage passe d'une voie à l'autre à une fréquence fixe (f ≈ 500 kHz).
ADD	La déviation verticale est la somme des signaux des voies A et B (ou −B).
B	La déviation verticale est commandée par le signal connectée à l'entrée de la voie B.
POSITION	Commande de décalage vertical continu de la trace.
PULL TO INVERT B	Bouton tirette combiné à la commande POSITION de la voie B. S'il est tiré, il y a inversion de signal de la voie B.
AMPL/DIV (bouton extérieur)	Réglage échelonné des coefficients de déviation verticale, de 2 mV/div à 10 V/div dans la progression 1-2-5.
AMPL/DIV (bouton central)	Réglage continu des coefficients de déviation verticale. Le coefficient de déviation n'est étalonné que si le bouton central est en position CAL (position extrême droite).
Commutateur de couplage d'entrée	Couplage de signal; deux boutons-poussoirs.
AC (enfoncé)	Couplage via un condensateur d'arrêt.
DC (libéré)	Couplage direct.
0 (enfoncé)	La connexion entre le circuit d'entrée et la prise d'entrée est coupée et le circuit d'entrée est mis à la terre.
A	Prise BNC pour entrée de la voie A.
B	Prise BNC pour entrée de la voie B.

2.2.3. Déclenchement

Commutateur de mode de déclenchement	*Fonction* Choix du mode de déclenchement et de la polarité de transition du déclenchement par cinq boutons-poussoirs. Si aucun bouton-poussoir n'est enfoncé, il y a automatiquement sélection du mode automatique et la gamme de niveau est fixe.
AUTO	Il y a affichage d'une trace en l'absence de signaux de déclenchement. La gamme de réglage du niveau est proportionnelle à la valeur crête-à-crête du signal de déclenchement.
AC	Déclenchement normal et gamme fixe de réglage du niveau. Le composant continu du signal de déclenchement est bloqué.

DC	Déclenchement normal et gamme fixe de réglage du niveau. Le composant continu du signal de déclenchement est transmis.
TV	Il y a synchronisation ligne ou trame suivant la position du commutateur TIME/DIV (trame de .5 s/div à 50 µs/div et ligne de 20 µs/div à .2 µs/div).
+/–	Le balayage est déclenché sur les flancs positifs au négatifs du signal de déclenchement. En TV, il faut choisir – pour les signaux vidéo négatifs et + pour les signaux vidéo positifs.
LEVEL	Commande pour le réglage continu du niveau de la forme d'onde sur laquelle l'affichage doit commencer.
TRIG OR X DEFL	(voir commutateur de source TRIG OR X DEFL dans la section 2.2.4. ci-dessous).

2.2.4. Déviation horizontale

Commutateur de source	*Fonction*
TRIG OR X DEFL	Quatre boutons-poussoirs permettent de choisir la source de déclenchement ou la source de déviation horizontale si le commutateur TIME/DIV est en position X DEFL. Si aucun des boutons-poussoirs n'est enfoncé, la source A est choisie.
A	Signal fourni par la voie A.
B	Signal fourni par la voie B.
COMP (A & B tous deux enfoncés; inopérant avec X DEFL)	Signal fourni après le commutateur électronique. Le déclenchement se fait sur les ondes telles qu'elles sont affichées.
EXT et EXT ÷ 10	Signal externe fourni à prise adjacente 1 Mohm//20 pF.
LINE (MAINS)	Signal fourni par la tension secteur (inopérant si l'instrument est alimenté par batterie).
X POSITION X MAGN	Commande de réglage continu du décalage horizontal de la trace; comporte un bouton tirette qui multiplie par 10 la déviation horizontale.
TIME/DIV (bouton extérieur)	Choisit la vitesse de balayage entre 0,2 µs/div et 0,5 s/div dans une progression 1-2-5. Choisit entre déclenchement ligne ou trame en mode TV. En position X DEFL, la déviation horizontale est déterminée par le commutateur TRIG ou X DEFL.
HOLD OFF	Commande pour augmenter le temps de blocage du balayage.
TIME/DIV (bouton central)	Réglage continu des vitesses de balayage. Doit être en position CAL (c'est à dire en position extrême droite) pour l'étalonnage de l'axe du temps suivant l'indication du commutateur TIME/DIV.

2.2.5. Divers

CAL	Prise de sortie fournissant une onde carrée de ≈ 2 kHz et une amplitude 1,2 Vcc ± 1 %. A utiliser pour compenser la sonde et/ou contrôler la précision de la déviation verticale.
Alimentation externe	Une prise d'entrée à l'arrière de l'instrument permet de le faire fonctionner sur une alimentation externe en courant continu. Tension d'alimentation de référence 22 à 27 V, courant admissible > 1 A.
Adaptateur de tension secteur	Le régler conformément à la section 2.1.2. avant de brancher l'instrument sur la tension secteur locale.
Entrée modulation -Z externe	Voir chapitre 3.6.

2.3. INSTRUCTIONS D'UTILISATION

2.3.1. Mise de l'instrument en circuit

Avant de connecter l'instrument à une source quelconque d'alimentation, il faut exécuter soigneusement les instructions de la section 2.1.
Normalement, l'oscilloscope fonctionne conformément à ses spécifications (voir section 1.2.) après une période d'échauffement d'environ 15 minutes. Toutefois, s'il a été exposé à une ambiance extrêmement froide, (par exemple laissé la nuit dans une voiture par temps de gel) et qu'on l'amène dans une pièce chauffée, il faut tenir compte d'une période d'échauffement suffisante (voir 1.2.8.).

2.3.2. Réglage préliminaire des commandes

Les opérations décrites ci-après donnent une indication générale de la correction de fonctionnement de l'oscilloscope. Elles constituent un préalable utile à l'exécution des mesures.
Voir la figure 2.2. pour la position des commandes.
Mettre les commandes INTENS et FOCUS en position médiane. Enfoncer AUTO et choisir une vitesse de balayage moyenne comprise entre 10 µs/div et 10 ms/div à l'aide du commutateur TIME/DIV.
Les autres boutons-poussoirs étant en position normale (non enfoncés), on peut positionner la trace des voies A et B sur l'écran à l'aide des commandes appropriées. Donner aux traces une brillance moyenne à l'aide de la commande INTENS et régler leur netteté à l'aide de la commande FOCUS.

2.3.3. Couplage d'entrée (AC/DC, 0)

Le couplage AC ou capacitif (bouton enfoncé) permet de bloquer le composant continu d'un signal. Le choix du couplage capacitif limite les fréquence inférieures, provoquant ainsi l'atténuation des signaux sinusoidaux à faible fréquence et la distortion des ondes carrées à faible frequence. Le degré d'atténuation est déterminé par le temps d'entrée RC (0,1 s). Le temps d'entrée RC est multiplié par 10 si l'on emploie des sondes passives 10 : 1.
Lorsqu'on passe au couplage capacitif, il faut attendre environ cinq fois le temps d'entrée RC avant que la trace se stabilise à la valeur moyenne du signal d'entrée. Les mesures de position AC ne peuvent être faites par rapport à la masse.

La position 0 déconnecte la source d'entrée et court-circuite l'entrée de l'amplificateur pour le contrôle du signal zéro.

Le couplage DC ou continu (bouton libéré) couvre toute la bande passante, c'est à dire jusqu'au courant continu.

2.3.4. Emploi de sondes

Les sondes passives 1 : 1 ne doivent être employées que pour le courant continu et les basses fréquences.
La charge capacitive atténue les hautes fréquences ou augmente le temps de montée des signaux de mesure (en fonction de l'impédance de source).
Les sondes passives 10 : 1 ont une charge capacitive moins grande, généralement environ 10 pF à 20 pF.
Les sondes FET sont supérieures, en particulier si les mesures doivent être prises en des points à impédance élevée ou à la limite supérieure de la bande de fréquence de l'oscilloscope.
Les sondes passives 10 : 1 doivent être compensées correctement avant emploi. Une compensation incorrecte provoque la distorsion des impulsions ou des erreurs d'amplitude aux fréquences élevées.
Pour un réglage correct, on peut utiliser la prise de sortie CAL (voir figure 2.3.).

2.3.5. Réglage des sondes atténuatrices

- Connecter la boîte de compensation à la douille A et mettre la pointe de la sonde à la douille CAL.
- Introduire un petit tournevis par l'ouverture de la boîte de compensation et ajuster le trimmer afin d'obtenir un affichage correct comme illustré à la figure 2.3.

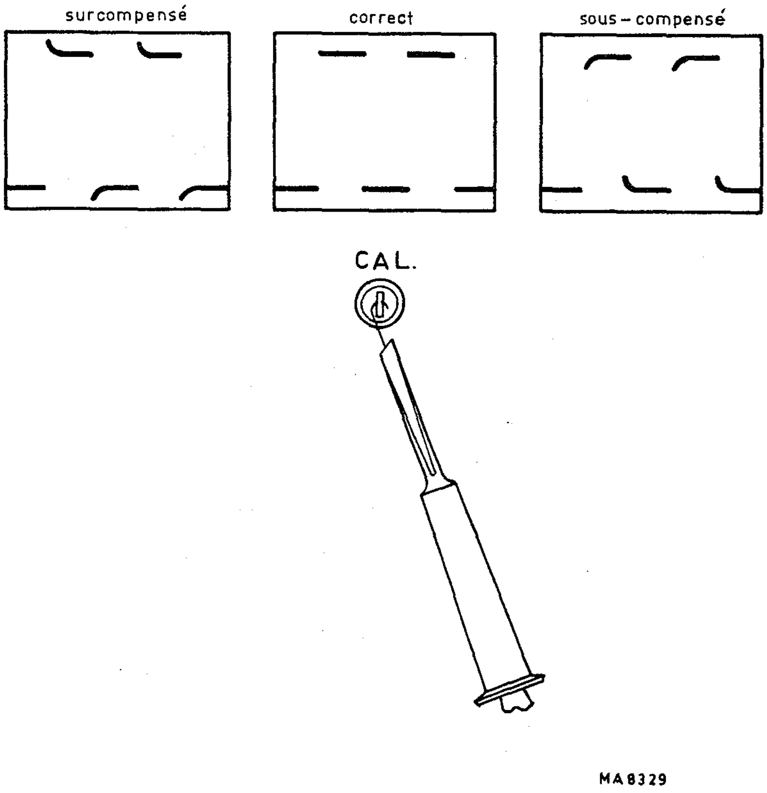


Fig. 2.3. Ajustage d'une sonde atténuatrice

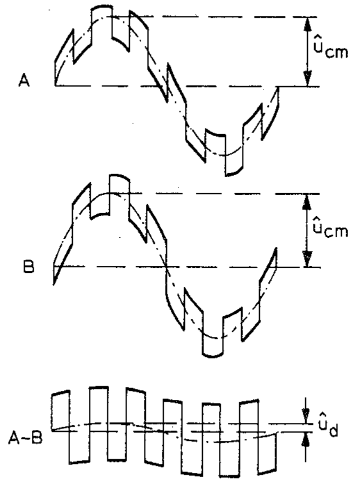
2.3.6. Choix entre modes commuté et alterné

(A .. ALT .. CHOP .. ADD .. B)

En fonctionnement à double trace (CHOP ou ALT enfoncé), il faut choisir le mode commuté (CHOP enfoncé) pour des vitesses de balayage relativement faibles (de 0,1 ms/div à 0,5 s/div) ou pour des faibles fréquences de répétition du balayage, même s'il est rapide. Le choix du mode alterné (ALT) dans ces conditions rendrait difficile la comparaison des formes d'ondes, parce que les traces apparaîtraient en fait successivement. Toutefois, si l'affichage est assez rapide pour être interrompu par la fréquence de commutation, il faut choisir le mode alterné (enfoncer ALT), généralement pour des vitesses de balayage supérieures à 0,1 ms/div.

2.3.7. Mode différentiel

On peut choisir le mode A-B en enfonçant ADD et en tirant la commande POSITION de la voie B.
Pour les mesures au cours desquelles il y a réception de signaux de mode commun de valeur appréciable (par exemple ronflement), le mode différentiel annule ces signaux pour ne conserver que la valeur intéressante (A-B). L'aptitude de l'oscilloscope à supprimer les signaux de mode commun est donnée par le coefficient de réjection mode commun (CMR) (voir figure 2.4.).
Pour obtenir le degré spécifié de réjection mode commun, il faut tout d'abord égaliser les gains respectifs des voies A et B. On peut obtenir ce résultat en connectant les deux voies au connecteur CAL et en ajustant l'un des commutateurs AMPL/DIV pour une déviation minimale sur l'écran.
Si l'on emploie des sondes passives 10 : 1, il est recommandé d'employer une méthode d'égalisation similaire consistant à régler leurs commandes de compensation pour une déviation minimale.



CMR(réjection en mode commun) $= \frac{\hat{U}_{cm}}{\hat{U}_d}$
Comme illustré ici CMR ≈ 10

Fig. 2.4. Réjection en mode commun

2.3.8. Choix du mode de déclenchement

(AUTO .. AC .. DC .. TV .. +/–)

Le mode AUTO est des plus utiles parce qu'il fournit une trace ou plusieurs traces sur l'écran, même en l'absence de signaux de déclenchement. De plus, pour un signal d'amplitude supérieur à 1 division, ce mode fournit un déclenchement stable indépendamment du réglage de niveau (LEVEL); sa gamme est automatiquement réglée sur la valeur crête à crête du signal choisi pour le déclenchement.
Cela facilite le réglage du niveau (LEVEL) à faibles amplitudes du signal de déclenchement.
Le mode AUTO ne peut être employé pour les signaux à faible fréquence de répétition (10 Hz ou moins) parce qu'il y aurait alors balayage en relaxé entre les déclenchements. Il faut donc utiliser le déclenchement normal (AC ou DC enfoncé) pour les signaux à faible fréquence de répétition.
En déclenchement normal, il n'y a balayage que si un signal de déclenchement est fourni et que le réglage de niveau (LEVEL) est approprié.
AC ou DC étant enfoncé, la gamme du niveau est fixe (+ ou –8 divisions ou plus de part et d'autre du milieu de l'écran). On peut bloquer le composant continu du signal de déclenchement en enfonçant AC. C'est utile, si le déclenchement doit être provoqué par des signaux alternatifs superposés à un niveau continu important.
En couplage capacitif, le niveau auquel l'affichage commence varie avec les modifications de la valeur moyenne du signal de déclenchement. Le niveau de référence du signal n'est donc plus rapporté au niveau de référence du signal. Ceci peut être une source d'instabilité des formes d'ondes avec variation de leur durée d'un cycle à l'autre. Il est normalement préférable d'employer la position DC.
Le choix de la pente s'effectue à l'aide du bouton-poussoir +/–. En mode TV il faut choisir – pour les signaux vidéo négatifs et + pour les signaux vidéo positifs. Dans ce cas, la commande LEVEL est inopérante.
Le non enfoncement des boutons offre une possibilité supplémentaire: l'écran affiche une trace en l'absence d'un signal de déclenchement, mais la gamme de niveau est fixe.

2.3.9. Source de déclenchement

La source de déclenchement se choisit à l'aide des boutons-poussoirs TRIG ou X DEFL en façade

A
B
EXT
EXT ÷ 10
COMP
LINE

- **Le déclenchement interne** est le plus couramment employé parce qu'il ne demande qu'un signal (le signal d'entrée) pour obtenir un déclenchement stable.
- **Déclenchement externe.** Si l'on affichage de nombreux signaux, il est préférable de se servir du signal externe pour le déclenchement. Il n'est pas nécessaire de régler à nouveau les commandes de déclenchement (LEVEL, SLOPE et SOURCE) à chaque changement de signal d'entrée. De plus, les deux entrées A et B restent libres pour l'examen des formes d'onde.
- **Choix de la source de déclenchement.** Pour comparer des formes d'onde synchrones à taux de répétition inégaux, toujours choisir comme source de déclenchement le signal qui a la fréquence de répétition la plus faible.
  Sinon, on risque d'obtenir des images doubles (mode commuté) ou des décalages de temps incorrects (mode alterné).
- **Déclenchement composite.** Dans le mode interne, les signaux de déclenchement sont fournis par les étages préamplificateurs de la voie A, ou de la voie B ou encore, si on choisit COMP en enfonçant à la fois les boutons A et B, par l'étage de commande de ligne à retard qui suit le commutateur électronique.

  Le déclenchement composite offre trois avantages:
  1. Dans le mode différentiel (A-B) le déclenchement est assuré par le signal différentiel et n'est donc pas perturbé par les signaux de mode commun.
  2. Pour le fonctionnement monovoie, il n'est pas nécessaire de commuter les sources de déclenchement de A à B ou vice-versa.
  3. En mode alterné, il est possible de comparer des signaux sans relation chronologique.

  Remarque: Si on emploie le déclenchement mixte en fonctionnement bivoie (commuté ou alterné) et qu'un seul signal est fourni (à l'entrée A ou B), on ne peut obtenir un déclenchement stable. C'est normal vu que la source de déclenchement est également commutée de A à B (voir figure 2.5.). Lorsque le déclenchement composite est utilisé en fonctionnement bivoie (mode alterné), le déclenchement stable n'est pas possible, car le système serait déclenché par les signaux transitoires de découpeur.

- **Le déclenchement par la fréquence secteur (réseau)** 50 Hz est utile si le signal est lié à la fréquence secteur.

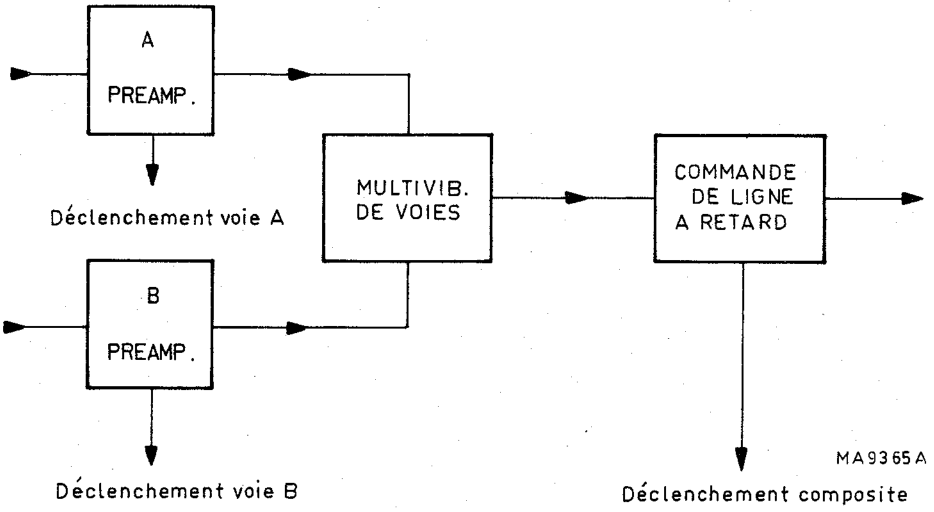


Fig. 2.5. Schéma synoptique du circuit de déclenchement composite

2.3.10. Agrandisseur de base de temps

L'agrandisseur est actionné par traction du commutateur incorporé dans la commande de positionnement X. Lorsque ce commutateur est en position x10, le vitesse de balayage de base de temps est agrandie 10 fois. Aussi le temps de balayage est-il obtenu en divisant par 10 la valeur TIME/DIV indiquée.

2.3.11. Réglage de blocage

Cette commande est utilisée pour augmenter le temps de blocage du balayage.

2.3.12. Mesures XY

Les mesures XY s'effectuent avec le commutateur TIME/DIV en EXT X DEFL, la source de déviation horizontale étant choisie à l'aide du bouton-poussoir TRIG or X DEFL (A, B EXT ou LINE).
Les mesures XY constituent un moyen utile de comparer des fréquences ou d'étudier des déphasages par l'affichage de figures de Lissajous.
Les mesures peuvent se faire jusqu'à 100 kHz avec une erreur de phase inférieure à 3° entre les voies horizontale et verticale.

Le tableau suivant indique la sensibilité dans les différents modes XY:

X déviation	Sensibilité
A	AMPL/DIV A ± 10%
B	AMPL/DIV B ± 10%
EXT	0,2 V/DIV
EXT ÷ 10	2 V/DIV
LINE	8 divisions

2.4. PROCESSUS REQUIS A LA DEPOSE DE FUSIBLES, VISIERE ET PLAQUE DE CONTRASTE

2.4.1. Dépose des couvercles

Toujours s'assurer que l'appareil est débranché avant de déposer les couvercles et plaques de l'appareil.
L'appareil est protégé par trois couvercles: un couvercle de protection à l'avant, une enveloppe avec poignée et une plaque arrière.
Pour faciliter la dépose de l'enveloppe et la plaque arrière, s'assurer d'abord que le couvercle avant est bien en position.

Procéder comme suit:
- Pivoter la poignée du couvercle avant. Pour ce faire, enfoncer les deux boutons centraux (Fig. 2.6.).
- Placer l'appareil avec couvercle frontal sur une surface plane.
- Desserrer les vis de la plaque arrière.
- Soulever la plaque arrière et déficher le connecteur sur la platine d'alimentation.
- Soulever l'enveloppe.
- Pour accéder au panneau avant, mettre l'appareil en position horizontale et déboîter le couvercle frontal.

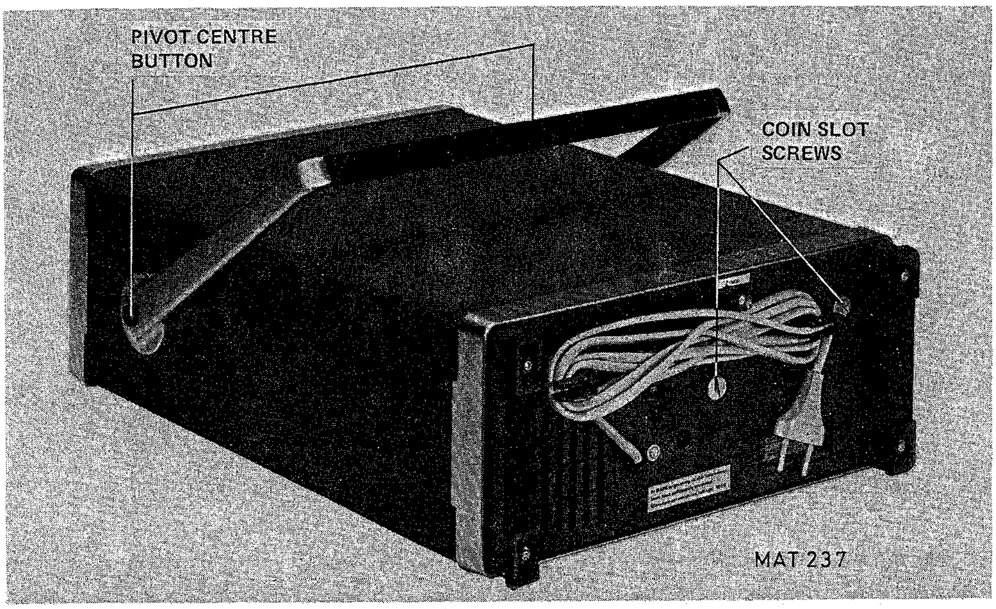


Fig. 2.6. Dépose des couvercles et de la poignée de l'appareil

2.4.2. Dépose du transformateur secteur

- Déposer l'enveloppe et le panneau arrière (section 2.4.1.).
- Enlever le couvercle du compartiment d'adaptateur de tension après dépose des 4 vis.
- Déposer les 4 vis du couvercle du compartiment de transformateur.
- Soulever le couvercle avec transformateur tout en faisant coulisser le fil entre le transformateur et l'adaptateur de tension de l'encoche pratiquée dans le compartiment de transformateur.
- Le transformateur et le fusible thermique sont alors accessibles.

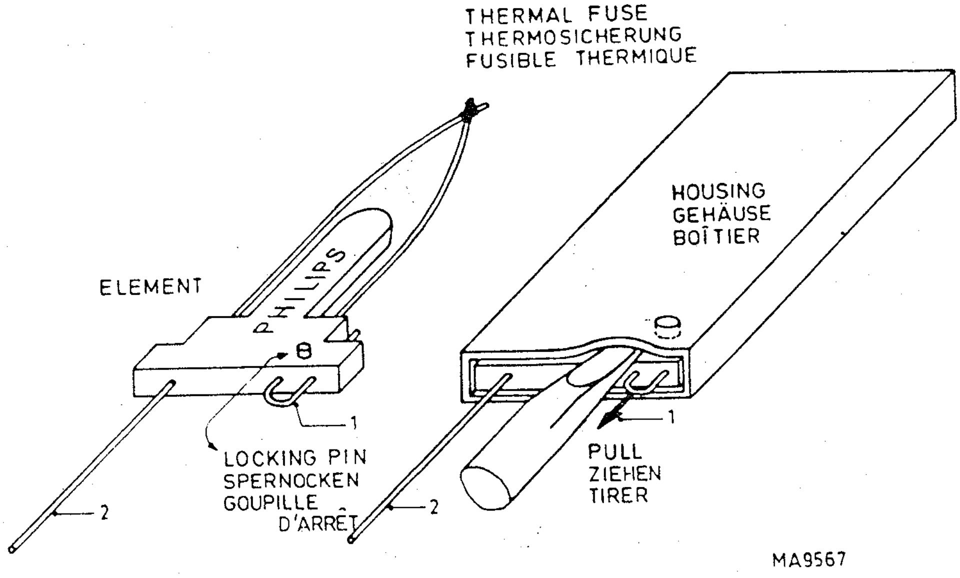

THERMAL FUSE
THERMOSICHERUNG
FUSIBLE THERMIQUE
HOUSING
GEHÄUSE
BOÎTIER
ELEMENT
PHILIPS
1
LOCKING PIN
SPERNOCKEN
GOUPILLE D'ARRÊT
2
2
1
PULL
ZIEHEN
TIRER
MA9567

Fig. 2.7. Remplacement d'un fusible thermique

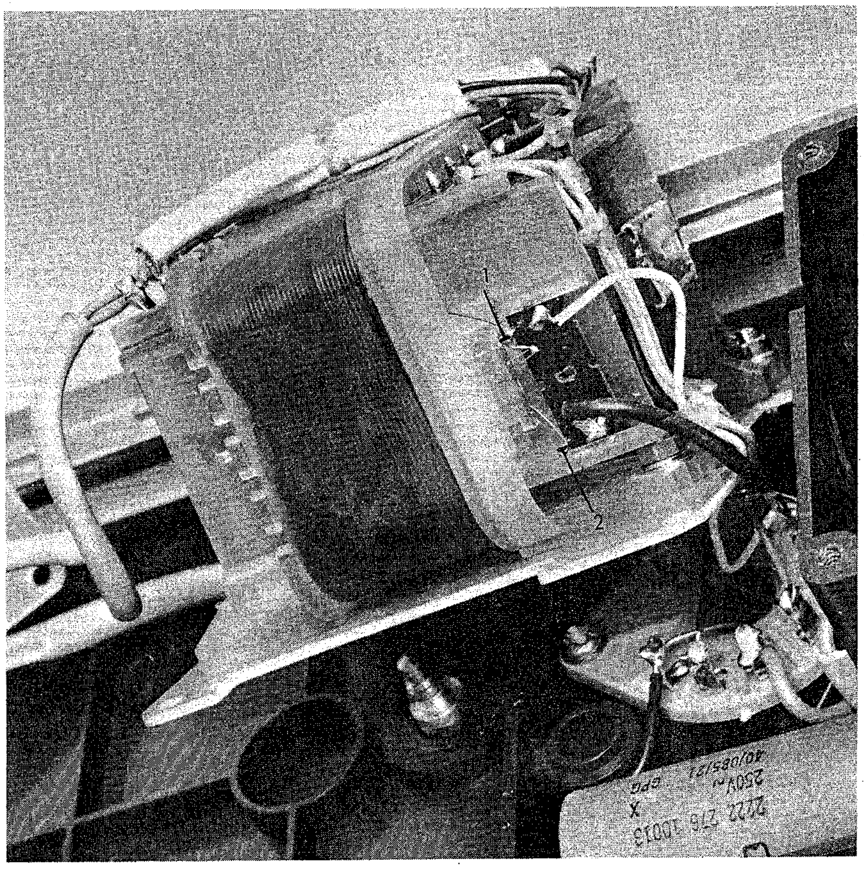


Fig. 2.8. Remplacement d'un fusible thermique

2.4.3. Remplacement d'un fusible thermique F101

- Déposer le transformateur secteur (section 2.4.2.).
- Dessouder les bornes de fusible 1 et 2 (Fig. 2.7. et 2.8.).
- Seul le fil de fusible est remplacé; à cet effet, plier légèrement vers l'extérieur, dégager le verrouillage et extraire le fil.
- Prendre un nouveau fusible et enlever le fil de fusible comme décrit précédemment.
- Enfoncer le nouveau fil dans l'ancien fusible jusqu'à ce que la goupille d'arrêt s'adapte dans le trou avec un déclic, la boucle du fil pointant vers la borne 1.
- Souder le fil de fusible aux bornes 1 et 2.

2.4.4. Remplacement du fusible F201

- Déposer l'enveloppe et le panneau arrière (section 2.4.1.).
- Fusible F201, lequel est situé sur le circuit imprimé de l'alimentation, est alors accessible en vue de son remplacement.

2.4.5. Dépose de la visière et de la plaque de contraste

- Prendre les coins inférieurs de la visière et la déposer du panneau avant par légère traction (Fig. 2.9.).
- Le filtre contraste est facilement démontable hors de la visière par légère pression.

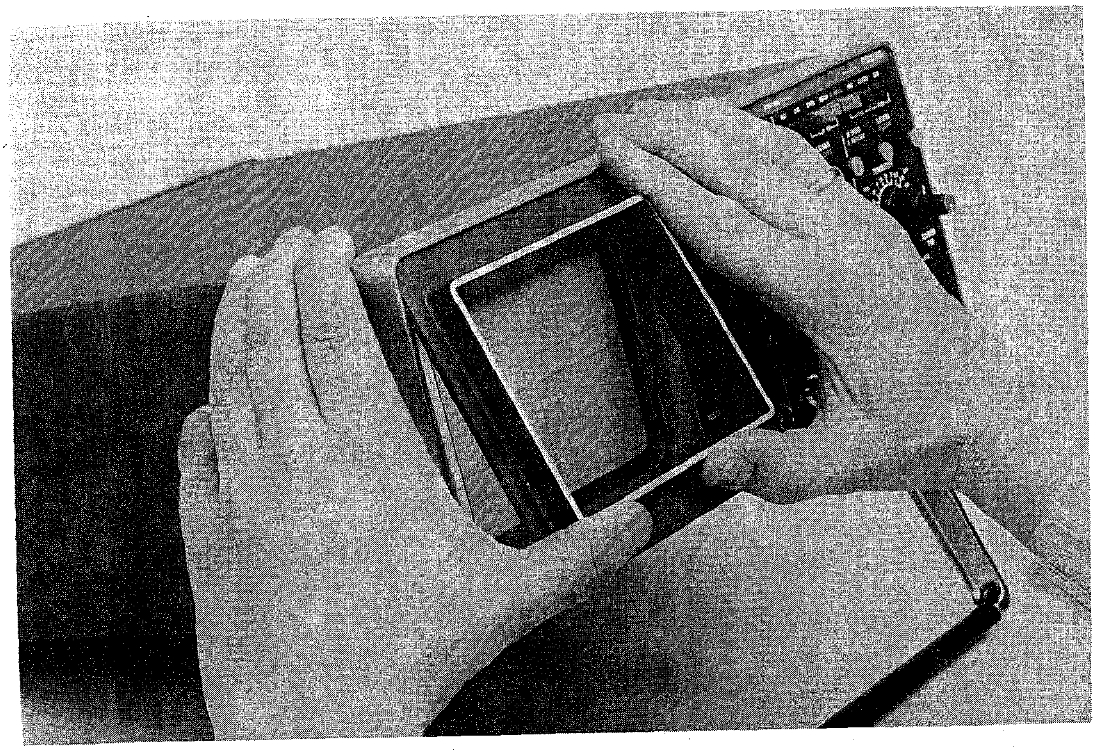


Fig. 2.9. Dépose de la visière et de la plaque de contraste

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3. Service data

3.1. CIRCUIT DESCRIPTION

3.1.1. Vertical deflection system

The vertical channels A and B for the signals to be displayed are identical, each comprising an input coupling switch, an input step attenuator, an impedance converter and a preamplifier with trigger pick-off.
A channel multivibrator, controlled by the display mode pushbuttons, switches either channel A or channel B to the final Y amplifier via the delay line driver and the delay line. The final Y amplifier feeds the Y deflection plates of the cathode-ray tube.
The individual stages of the vertical deflection system are now described in some detail.
As the signal paths for channel A and channel B are basically identical, only the channel B signal path is described.

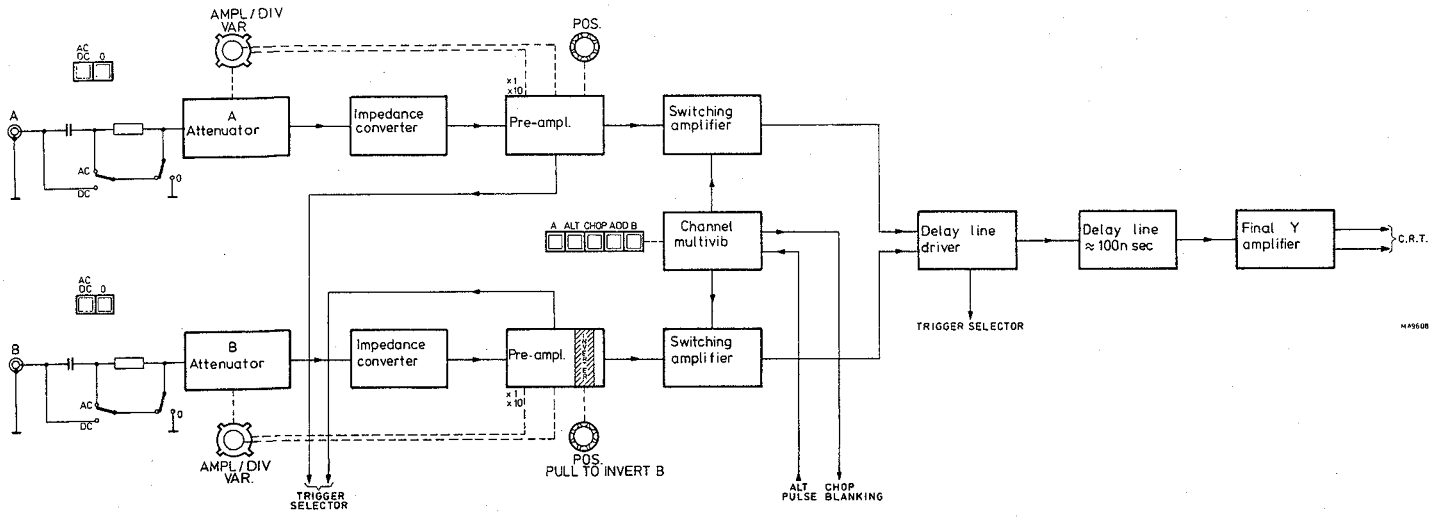

AMPL / DIV
VAR
POS.
AC
DC
0
A
A
Attenuator
Impedance converter
Pre-ampl.
x1
x10
Switching amplifier
AC
DC
0
A ALT CHOP ADD B
Channel multivib
Delay line driver
Delay line
≈ 100n sec
Final Y amplifier
C.R.T.
TRIGGER SELECTOR
MA9608
AC
DC
0
B
B
Attenuator
Impedance converter
Pre-ampl.
INVERTER
x1
x10
Switching amplifier
AC
DC
0
AMPL / DIV
VAR.
POS.
PULL TO INVERT B
TRIGGER
SELECTOR
ALT
PULSE
CHOP
BLANKING

Fig. 3.1. Vertical deflection system

3.1.1.1. Input coupling

Input signals connected to the B input socket X3 can be a.c. coupled, d.c. coupled or internally disconnected.
In the AC position of S14, there is a capacitor (C401) in the signal path. This capacitor prevents the DC component of the input signal from being applied to the amplifier.
In position DC of switch S14, the input signal is coupled directly to the step attenuator.
At the same time, blocking capacitor C401 is discharged via R402, to prevent damage of the circuit under test by a possible high charge.
S15 (0) isolates the B input signal and earths the channel input for reference purposes; e.g. for calibration or centering the trace.

3.1.1.2. Input attenuator

The input attenuator is a frequency-compensated, high-impedance voltage divider with twelve positions. The overall attenuation of the stage is determined by the combination of the selected sections of two voltage dividers. The various combinations are selected by the twelve positions of the frontpanel AMPL/DIV attenuator switch S8.
The first divider sections attenuate by factor of 1.25, 3.125 and 6.25 and the second divider sections attenuate by a factor of 1x, 10x and 100x.

With the overall combinations of attenuation, nine Y deflection coefficients are realised from 20 mV/div to 10 V/div in a 1-2-5-sequence. Only for the most sensitive positions 2 mV/div, 5 mV/div and 10 mV/div of AMPL/DIV attenuator switch S8, the gain of the Y amplifier is increased by a factor of 10.
The input capacitance of the attenuator cannot be adjusted in the individual positions. Small differences of approx. 1 pF are allowed.
The voltage divider sections are made independent of the input frequency over the frequency range of the oscilloscope (i.e. 35 MHz) by means of the trimmers C407, C413, C414, C416, C417, C418 and C419.

3.1.1.3. Impedance converter

The impedance converter is formed by V604 (two matched field-effect transistors). The two FET transistors are used in source follower configuration.
The signal level on the gate (and on the source) of the upper FET amounts to 1,6 mV/div or 16 mV/div.
Diode V601 together with the output impedance of the attenuator and also the attenuator action protects the input source follower, against excessive negative input signals. The d.c. balance of the circuit can be adjusted with R604, providing attenuator balance for the 10 mV/div and 20 mV/div positions.

3.1.1.4. Preamplifier

The input stage formed by D601 (5 transistors) is switched in a Cherry-Hooper configuration and direct coupling is employed throughout.
In the positions 20 mV/div – 10 V/div of the AMPL/DIV switch S8, contact K601 is open and the gain is determined by

$$\frac{R628 + R632}{R611 + R612} = \text{approx. } 1{,}8\text{x}$$

If K601 is closed (in positions 2 mV/div, 5 mV/div and 10 mV/div) the gain of this stage is increased by a factor of 10. This is accurately adjusted with R621.
To prevent jumping of the trace when K601 is switched with the input short circuited, no voltage must be present across these contacts. R604 (attenuator balance) serves this purpose.
R8 in conjuction with R622, R623, R624 and R626 forms the vernier control. In the calibrated position (R8 is 1 kohm) the transfer of this network is 0,85x. With R8 to its minimum position (0 ohm) the transfer is 0,3x. Thus we have a control range of 3x.
V608, V609, V613, V614, V616 and V617 form a symmetrical cascode circuit supplying an output CURRENT to the channel switch.
The transfer conductance of this stage is:

$$\frac{I_{out}}{U_{in}} = \frac{1}{R641 \,//\, (R637 + R638) \,//\, (R646 + R647 + R648)} = 7\text{ mA/V}$$

The signal level at the input of this stage is approx. 24 mV/div equivalent to approx. 170 µA/div at the output.

Note: The channel A gain can be equalised to the channel B gain with the aid of R543 (gain x1 in channel A amplifier).

3.1.1.5. Trigger pick-off

The trigger signal is picked-off at the emitters of V608 and V609, a signal source with a low internal resistance, by the series feed-back stage V611 and V612.
From this stage the trigger signal current is fed asymmetrically to the trigger selector via a 50 Ω cable.

3.1.1.6. Normal invert switch

The B channel has a provision for inverting the polarity of the Y signal. Push-pull switch S4, PULL TO INVERT B, is mounted on the shaft of front-panel control B POSITION. In the invert position of the switch the normal signal paths are blocked because V613 and V614 are switched off.
Inversion is achieved by V616 and V617 providing alternative paths for the signal when their bases are switched less positive by S4. Possible unbalance between the two positions of the switch can be compensated by preset potentiometer R647 (Norm invert balance).

3.1.1.7. Position control

Potentiometer R3 is the vertical POSITION control. Its balance is adjustable by means of R674 (shift balance).

3.1.1.8. Channel multivibrator

The channel multivibrator consists of two circuits which are inserted in the A and B channel signal paths.
The A channel circuit consists of the transistors V524, V526 and the diodes V521, V522 and V523. The B channel circuit consists of the transistors V624 and V626 and the diodes V621, V622 and V623.
When the junction of the three diodes is positive in relation to mass, the diodes are non-conductive. The transistors, and thus, the signal path are conductive.
If the current drained from the junction exceeds 6 mA, the diodes are conductive and the transistors are turned off.
The circuits are driven from the flip-flop formed by the transistors V703 and V704.
With A (S1A) depressed: only channel A is displayed.
The base of V703 is connected to the −12 V supply voltage. V703 is turned-off then, its collector voltage is high and channel A is switched on. At the same moment channel B is switched off.

With ALT (S1B) depressed: channels A and B are alternately displayed.
This push-button is a dummy and has no contacts, but it releases all the other pushbuttons of the display-mode controls. In this mode there is a DC path via R704 between the two emitters, the circuit is bi-stable and one of the diodes is conductive.
V1201 is not conducting in ALT mode and negative going alternate pulses derived from the time-base generator are fed to the circuit. These pulses switch the circuit at the end of each sweep and the channels A and B are alternately displayed.

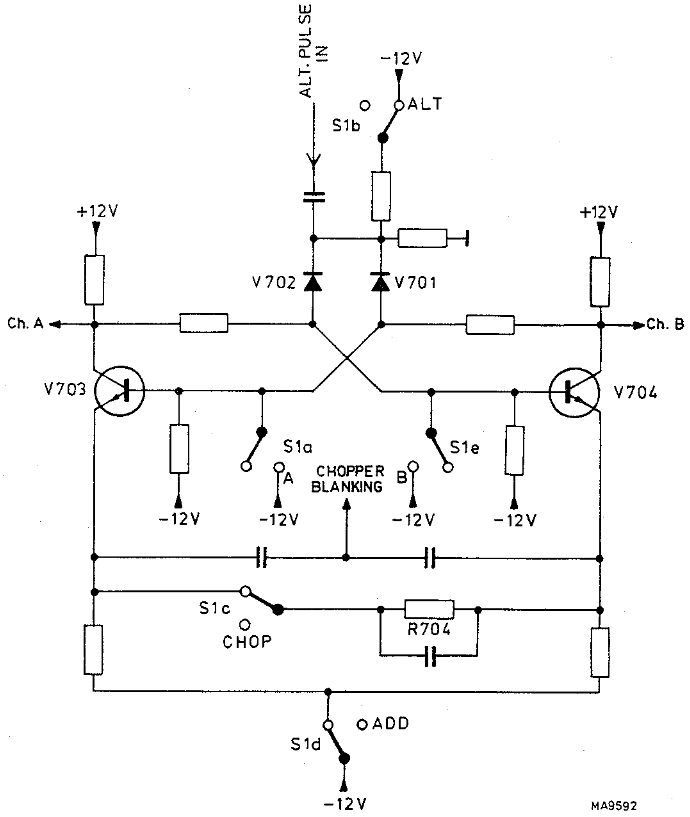


Fig. 3.2. Simplified diagram of the channel multivibrator

In the ALT mode −12 V is applied via S1A, S1C, S1D and S1E and R710 to transistor V1506 in the beam blanking amplifier.
This transistor is then blocked and the only control signal for the beam unblanking amplifier is the normal unblanking pulse coming from the time-base circuit.

With CHOP (S1C) depressed: channels A and B are chopped.
In this mode the circuit acts as a chopper generator. S1C is open then, the DC path between the emitters of V703 and V704 is interrupted and the circuit is a-stable. Both diodes V701 and V702 are then turned-off and the circuit starts oscillating, the oscillating frequency being approx. 500 kHz.
During the switching transients in the CHOP mode, the c.r.t. is blanked with the aid of differentiated chopper blanking pulses (at the junction of R703 and C702) which are fed to the Z-amplifier.

With ADD (S1D) depressed: channel A and B are added.
Both transistors are turned-off, both collector voltages are high and both channels are switched on.

With B (S1E) depressed: only channel B is displayed.
The base of V704 is connected to the −12 V supply voltage. V704 is then turned-off, its collector voltage is high and channel B is switched on. At the same moment channel A is switched off.

3.1.1.9. Delay line driver

The symmetrical delay line is sandwiched between a series feed-back push-pull amplifier (called CHERRY) and a shunt feed-back push-pull amplifier (called HOOPER), consisting of integrated circuit D801.
Such an amplifier combination is called "CHERRY-HOOPER".
The series feed-back stage receives a signal of approx. 30 mV/div which is obtained from a signal current of 0,17 mA/div from the channel switch, multiplied by the value of the load resistance R803 + R804 = 200 Ω.
The emitter impedance of the series feedback stage consists besides RE = R819 + R821 of the parallel circuit of a number of RC networks. As the delay line is a source of distortion for higher frequencies, these networks are realizing the necessary delay line compensation.
At the input side, delay line D802 terminates in R828 and R829 (totally 200 Ω).
The delay line itself is a symmetrically mount spiralized cable with a characteristic impedance of 200 Ω and a delay of 110 nsec/m. At the output side, the cable terminates via R831 and R832 in the virtual earth points of the parallel feed-back stage (HOOPER). The input impedance on these virtual earth points is 14 Ω. This value in series with the 86.6 Ω of R831 and R832 forms the correct termination for the delay line. C814 and C816 are for HF correction.

3.1.1.10. Composite trigger pick-off

The composite trigger signal is picked-off at the emitters of the CHERRY stage (D801), a signal source with a low internal resistance, by the series-feedback stage V802 and V803. From this stage the composite trigger signal current is fed asymmetrically to the trigger selector via a 50 Ω cable.

3.1.1.11. Final Y amplifier

The output signals of the "HOOPER" stage are applied to the final Y amplifier stage consisting of the transistors V804, V806, V807 and V808, which are configurated as two series feed-back amplifiers in parallel fed by a constant current source.
The gain of the final amplifier can be set by means of potentiometer R848. The centre taps of the coils L801 and L802 are connected to the Y deflection plates of the c.r.t. The Y deflection plates form filters together with the coils L801 and L802. These filters terminate in resistors R859, R861, R862 and R863.

3.1.2. Triggering

The trigger source switches for triggering the time-base generator, can select any of the following input sources:
- an internal signal from the vertical A channel
- an internal signal from the vertical B channel
- an internal composite signal of channel A and channel B
- a signal derived from the mains supply
- an external source
- an external source divided by 10

All these sources can be used for both triggering and X deflection purposes. Source selection is done by means of a trigger selector switch S16 that feeds the trigger signals to the trigger amplifier.

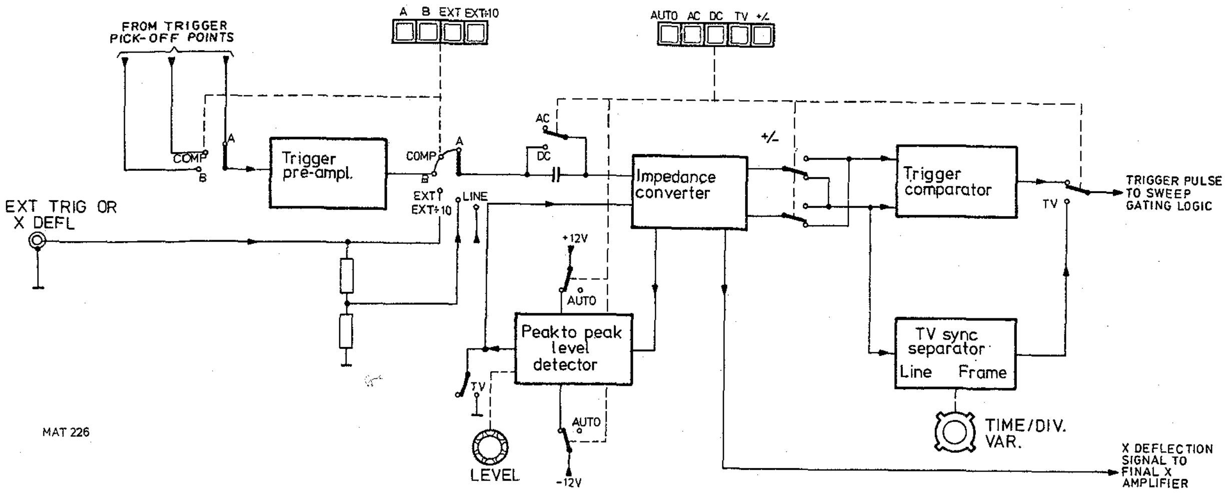

FROM TRIGGER PICK-OFF POINTS
A B EXT EXT÷10
AUTO AC DC TV +/-
COMP
A
B
Trigger pre-ampl.
COMP
A
B
EXT
LINE
EXT÷10
AC
DC
Impedance converter
+/-
Trigger comparator
TV
TRIGGER PULSE TO SWEEP GATING LOGIC
EXT TRIG OR X DEFL
+12V
AUTO
Peak to peak level detector
TV
LEVEL
AUTO
-12V
TV sync separator
Line Frame
TIME/DIV. VAR.
X DEFLECTION SIGNAL TO FINAL X AMPLIFIER
MAT 226

Fig. 3.3. Trigger circuit

3.1.2.1. Trigger source selection and preamplifier

The signal currents (60 μA/div) of the three trigger pick-off stages are, after selection by S16C and S16D, amplified to a level of 100 mV/div by a shunt feed-back stage + emitter follower stage consisting of V351 and V352. After this stage there is a selection between its output signal, a signal on the external socket and a signal with the line frequency by means of S16A and S16B. Signals that are not used are short-circuited to mass.

The externally applied signal is attenuated by a factor of two or twenty (depending on position of EXT and EXT ÷ 10) allowing standardisation of the input impedance of the EXT socket to 1 MΩ//20 pF.

3.1.2.2. Impedance converter

The trigger signal of 100 mV/div is fed via the AC-DC coupling switch S2C to a FET (V1006) in source follower configuration.
From here the signal is applied via an emitter follower to the ± slope selection switch S3. This selection switch enables triggering on either the positive-going or the negative going edge of the triggering signal.

3.1.2.3. Trigger comparator

From the ± slope selector switch S3 the signal is fed via a common emitter amplifier D1001(123/345) to the output shunt feed-back amplifier V1014 via the TV mode switch S2D. The voltage gain is high (28x) but its dynamic range is small (2.8 Vp-p at the output). This is because of the tail current of the symmetrical common emitter stage is 2 mA. The current sweep at the output of this stage is consequently 2 mA at max. which is transformed into a 2,8 V max. voltage sweep at the output of the shunt feed-back amplifier V1014. This means that the trigger amplifier is completely driven at a trace height of 1 div. Which division on the screen this is, depends on the position of the LEVEL control R5.
With AC (S2B) or DC (S2C) depressed, the range of the LEVEL control is fixed. The DC voltage at the wiper of LEVEL control R5, which is fed to the FET (V1006) can vary between +3.5 V and –3.5 V. Diodes V1001 and V1002 are then turned-off, and the voltage on the gate of the FET is then adjustable between +0.9 and –0.9 V. At a signal level on the gate of the other FET of 100 mV/div, there will be a control range of ± 9 div.

3.1.2.4. Peak to peak level detector

If the AUTO push-button S2A is depressed, the supply voltages for the level control circuit are interrupted.
A trigger signal (300 mV/div) which is derived from the emitter follower stage and amplified by V1008, gives after peak to peak detection a DC voltage across the level control. This DC voltage is approx. proportional to the amplitude of the trigger signal. This is the auto trigger level control. The peak-to-peak level of the signal then determines the range of the level control.

3.1.2.5. *T.V. Synchronisation separator*

If the TV mode push-button S2D is depressed, the LEVEL control is switched off. The wiper of R5 is then connected to mass. A synchronisation separator for the television signals is then inserted into the trigger signal path.

A composite video signal contains, besides the video information, also synchronisation pulses with line and frame frequency which can be distinguished by their pulse width.
The TV synchronisation separator circuit is able to:

1. separate the synchronisation pulses from the video information.
2. distinguish between frame synchronisation pulses and line synchronisation pulses.

The first requirement is met by V1013 acting as a DC restorer and limiter, the second requirement by the integrating network R1047, C1011 and C1012.
The TV signal is picked-off at the ± slope selector switch which in this case can be set for the right polarity of the TV signal. The TV trigger signal is then amplified by the series feed-back push-pull stage V1009, V1011 and applied to synchronisation separator V1013 via emitter follower V1012. The signal on the base of V1013 could be as follows:

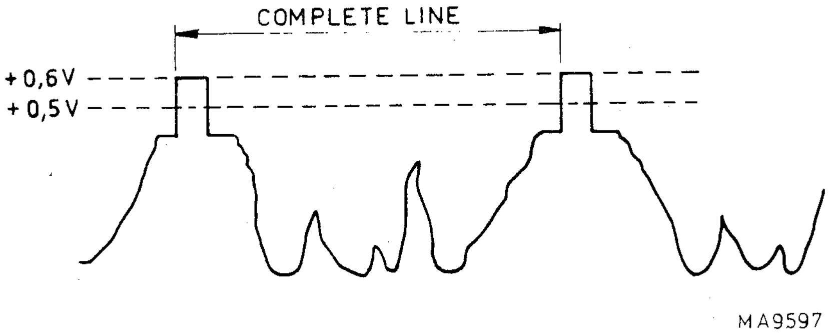


Fig. 3.4. Signal on the base of transistor V1013

The peaks of the synchronisation pulses are all at one level by the DC restorer action of C1007, R1039 and the base emitter diode of V1013. The base voltage will never exceed +0.6 V by a large amount, but the complete waveform will appear at the base. The signal level is at this point approx. 280 mV per screen div. Change in signal of approx. 100 mV is sufficient to turn off V1013. V1013 looks only to the peaks of the synchronisation pulses.
The rest of the TV signal has no influence. On the collector of V1013 we find exclusively the synchronisation signal consisting of line synchronisation pulses and the wider frame synchronisation pulses.

In the time base positions 20 µsec/div and faster, this complete signal is transmitted to the time base generator and we have line triggering.
In the time base positions 50 µsec/div. and slower, C1011 and C1012 are connected to mass. The narrower line synchronisation pulses are then, integrated out of the signal, but the wider frame synchronisation pulses remain, and frame triggering is obtained. A second threshold is built-up by V1016. V1017 reacts to the signal that still passes and consists of pure line or frame synchronisation pulses. After this the signal is fed to the time base generator via V1014.

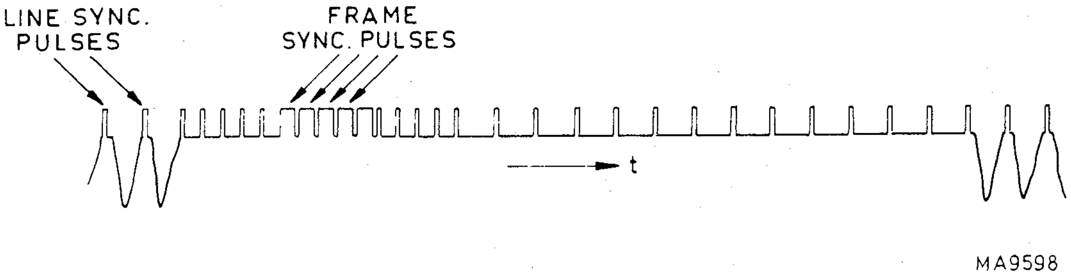


Fig. 3.5. A vertical interval with frame synchronisation pulse group

3.1.3. Time-base generator

The time-base generator comprises a sweep gating logic, a sweep generator, a hold-off circuit, an auto sweep circuit and X final amplifier.

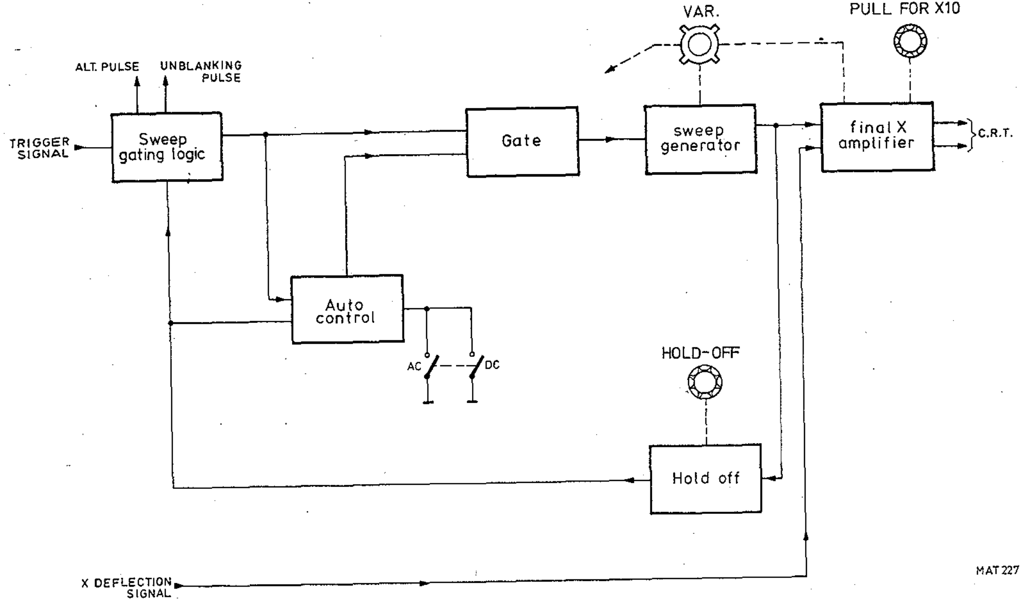


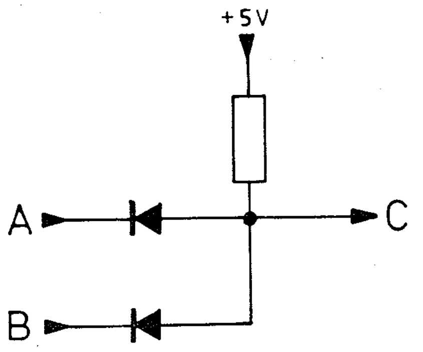
Fig. 3.6. Time-base generator

Before considering these stages in detail, the general principle is briefly described. Basically, the sweep gating logic, under the control of trigger signals from the trigger comparator and also feedback pulses from the hold-off circuit, supplies square-wave pulses to the switching transistor V1213 of the sawtooth generator. The time-base capacitors (effectively in parallel with the switching transistor) are charged linearly through a constant-current source to provide the forward sweep, and are discharged rapidly by the switching transistor to provide the flyback period. The resulting sawtooth is fed to the X-final amplifier.

3.1.3.1. Sweep generator

The sweep speed or time coefficient is determined by the value of the time-base capacitance in circuit, and also by the magnitude of the charging resistor selected.
The time-base capacitors are C1204 and C1207. Capacitor C1204 is always in circuit, the other one is selected by the transistor V1216. This transistor operates as an electronic switch and is either fully cut-off or fully-conducting. It is switched on by the application of a positive voltage to its base from the TIME/DIV switch S10. According to the position of S10, this transistor V1216 switches in the capacitor C1207 in parallel with C1204. As mentioned, the sweep speed is also dependent upon the magnitude of the accurate constant-current supplied by transistor V1212. This current can be adjusted in steps by selecting the emitter resistance of V1212 by means of the TIME/DIV switch S10. Continuous control of the charging current can be effected by varying the base drive to V1212 with the continuous sweep control, TIME/DIV potentiometer R9. In the CAL position of this potentiometer, switch S11 closes and the charging current is solely determined by the calibrated emitter resistance.
To compensate for the temperature coefficient of the transistor, the base voltage of V1212 is supplied via transistor V1214.
This also has the advantage of reducing the load on the TIME/DIV potentiometer R9.
This transistor, in turn, has its base controlled by preset potentiometer R1232 when TIME/DIV switch S10 is in one of the positions .5 s/div ... .5 ms/div. This provides a fine adjustment for the timing circuit in the slower sweep speeds. In these positions the preset potentiometer R1232 provides an additional measure of control over the base voltage of V1212. In the positions of S10 when C1207 is not in circuit, the diode V1218 is blocked and the preset control R1232 is inoperative.

The discharge circuit for the capacitors C1204 and C1207 consists of resistor R1219 and transistor V1213. This switching transistor is driven by the sweep gating logic via a number of diodes. Diodes V1207 and V1208 form an AND-gate for positive logic; V1209 and V1211 adapt the level to control transistor V1213.
The resulting sawtooth voltage is taken from two transistors V1219 and V1221 in a kind of Darlington pair configuration.



A	B	C
0V	0V	0V
+5V	0V	0V
0V	+5V	0V
+5V	+5V	+5V

MA9600

Fig. 3.7. AND-gate for positive logic

C1209 improves the transfer of faster sawtooth signals at the expense of the input impedance which need not to be that high then. The sawtooth voltage amplitude is approx. 5 V. This sawtooth voltage is then fed to the X-final amplifier.

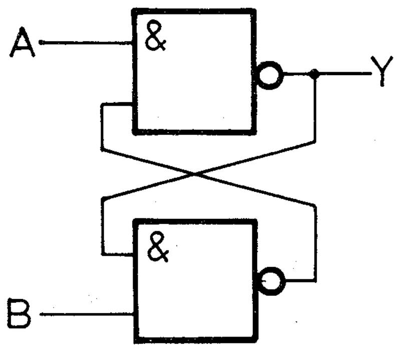
3.1.3.2. *Hold-off circuit*

The hold-off circuit prevents the sweep gating logic from responding to trigger pulses before the time-base capacitor has fully discharged. The sawtooth output from the Darlington pair V1219 and V1221 is applied to the base of emitter follower V1223.
The switching transistor V1217 switches the hold-off capacitor C1208 in circuit, parallel to C1206, according to the position of the TIME/DIV switch S10, in a similar manner to that described for the time-base integrator timing capacitor. Capacitor C1206 is always in circuit irrespective of the TIME/DIV switch position.
Charging current for the hold-off capacitors flows via transistor V1223. When V1223 cuts off the discharge current flows through R1228 and hold-off control R12. This current is adjustable to change the hold-off time.
The voltage across hold-off capacitor C1206 or C1206 + C1208 follows the sawtooth voltage fairly fast in positive going direction via emitter follower V1223. When a certain value is reached, integrated Schmitt-trigger D1201 reacts and the end of the sweep is initiated.
This is followed by a hold-off period in which the voltage across the hold-off capacitor decreases fairly slowly until the lower switching level of the Schmitt trigger is reached. The system can now be triggered again. In the mean-time also the time-base integrator timing capacitor C1204 or C1204 + C1207 has reached its quiescent state. The output (point 6) of D1201 is low during the hold-off time, at any other moment this output is high.

3.1.3.3. *Sweep gating logic*

The sweep gating logic which consists of TTL logic circuits is controlled by the following signals:
- The trigger signals supplied by the trigger comparator.
- The voltage supplied by the hold-off circuit.
- The voltage supplied by the auto circuit via the hold-off circuit.

The TTL circuit D1201 contains four 2-input NAND-gates with Schmitt-trigger properties.
D1202 contains four normal 2-input NAND-gates and D1203 contains three normal 3-input NAND-gates.
With the aid of the various gates two flip-flops are formed.



A	B	Y
0	0	1
0	1	1
1	0	0
1	1	Old situation

Fig. 3.8. Flip-flop symbol

Y is $\bar{A}$, if B is 0
Y is 1, if A is 0

The circuit is set by A is 0 (when B is 1) and reset by B = 0 (when A is 1).
See relation diagram of the sweep gating logic in the AC or DC mode.

1 The incoming trigger signal from the trigger comparator switches the Schmitt-trigger output (D1201, point 11) to zero after a positive going edge has exceeded the upper switching level (+1.7 V) of this Schmitt-trigger.

2 After this, the first flip-flop output (D1202, point 3) is set to the logic 1-state.

3 If the negative going edge of the incoming trigger signal drops below the lower switching level (+0.9 V) of the Schmitt trigger, the output (D1201, point 11) switches to logic 1 level again.

4,5,6 The logic 1 state of the first flip-flop and the output signal of the Schmitt-trigger allows the setting of the second flip-flop output (D1203, point 6) to the zero state by means of the NAND output (D1202, point 11).

7 The output signal of the second flip-flop is applied to switching transistor V1213 via an OR-gate which consists of R1216, V1207 and V1208. This signal causes the sweep to start.

8 The end of the sweep is reached when the signal across the hold-off capacitor C1206 exceeds the upper switching level (+1.7 V) of the hold-off Schmitt-trigger. The output of this Schmitt-trigger switches then to zero.

9 Both flip-flops are now reset. Switching transistor V1213 starts conducting and time-base capacitor C1204 will discharge.

10 The voltage across the hold-off capacitor C1206 decreases slowly until the lower switching level (+0.9 V) of the Schmitt-trigger is reached.

11 This is the end of the hold-off period. The output (D1201, point 6) of the hold-off Schmitt-trigger rises to 1 again and the system can be triggered again.

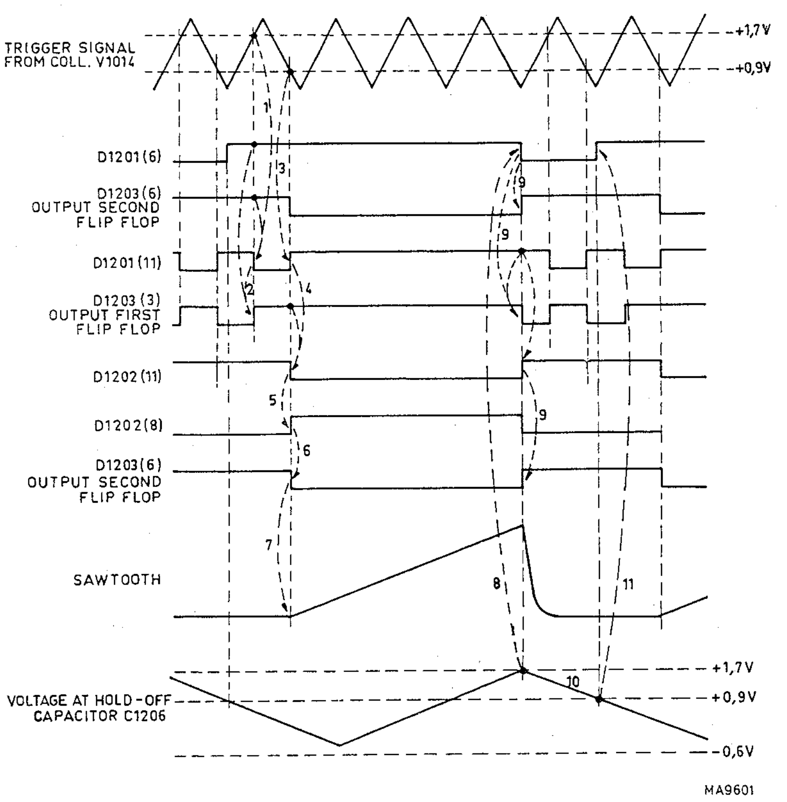

TRIGGER SIGNAL FROM COLL. V1014
+1,7V
+0,9V
D1201(6)
D1203(6) OUTPUT SECOND FLIP FLOP
D1201(11)
D1203(3) OUTPUT FIRST FLIP FLOP
D1202(11)
D1202(8)
D1203(6) OUTPUT SECOND FLIP FLOP
SAWTOOTH
VOLTAGE AT HOLD-OFF CAPACITOR C1206
+1,7V
+0,9V
-0,6V
1
2
3
4
5
6
7
8
9
10
11
MA9601

Fig. 3.9. Time relation diagram of the sweep-gating logic in the AC or DC mode

3.1.3.4. Auto sweep circuit

In the absence of a trigger signal we would still like to see a display on the screen. The auto sweep circuit serves this purpose. Transistor V1203 senses the state of the output of the second flip-flop, this is the output of the sweep gating logic. Whenever this point reaches the logic zero level, transistor V1203 starts conducting enabling C1202 to discharge. Transistors V1204 and V1206 are then turned off. The collector of V1206 lies on −0,7 V potential and the relevant gate of D1201 is then blocked. This means that output D1201 (3) is at logic 1 level (+5 V).

In the absence of a trigger signal, the output D1203 (6) of the sweep gating logic remains a logic 1 level (+5 V) and transistor V1203 remains turned-off. The voltage across capacitor C1202 remains increasing until after approximately 100 msec., transistor V1204 starts conducting and causes transistor V1206 to conduct. The collector of V1206 rises to approximately +5 V and the relevant gate of D1201 opens. The hold-off signal on point 6 of D1201 now can reach via gate D1201 (3) and the OR-gate, the switching transistor V1213. The loop is then closed and the time base generator is in the free running mode.

3.1.3.5. X-final amplifier

Transistor V1407 is driven by either the time-base generator via diodes V1411 and V1409 when R1406 is kept at +12 V level via TIME/DIV switch S10 (in all the TIME/DIV positions of this switch), or the amplifier stage V1404 when R1407 is kept at +12 V level via TIME/DIV switch S10 (in position X DEFL).

Transistor V1404 receives its input signal from D1001 point 8 of the trigger amplifier.

This signal is derived from one of the sources, channel A, channel B, line or an external source, depending on the setting of the X deflection selector switch S16.

The final X amplifier consists of two amplifier stages in parallel (one for each deflection plate).

Only one half is described.

The actual amplifier is the cascode circuit with transistors V1414 and V1416.

The resistors R1428 and R1429 are feedback resistors. The bias current for the amplifier is supplied by transistor V1413. The average voltage on the deflection plate is kept at +26 V by means of zener diodes V1424 and V1426. Capacitor C1413 improves the h.f. response.

This final stage is supplied from the +180 V and −180 V because the X plates of the C.R.T. are mechanically displaced such that they are less sensitive than the Y plates.

The cascode amplifier stages are controlled via the transistors V1406 and V1407.

The bias of transistor V1406 can be varied with the X POSITION potentiometer R4, which consists of a tandem potentiometer with back-lash, giving a nice vernier control. Variation of the bias causes the balance of the amplifier to be disturbed, which results in a horizontal trace shift on the screen.

The X amplifier allows choice from X deflection by the time base signal or one of the sources, channel A, channel B, line or an external signal. The deflection source is selected with the aid of the TIME/DIV switch S10 and the X-deflection source selector switch S16.

The X amplifier offers the possibility of using either the nominal gain (x1 position of X MAGN switch S5), or the gain increased by a factor of 10 (x10 position of the X MAGN switch S5).
When the front-panel X MAGN switch is operated for 10x magnification, the emitter resistance R1416 + R1417 of transistors V1406 and V1407 is shunted by resistors R1418 + R1419 reducing the value by a factor of 10. Consequently, the gain of the stage is increased by the same factor.
The x1 gain can be set by potentiometer R1417 and the x10 gain by potentiometer R1419. The x10 gain is also operative when X DEFL is selected.

Both outputs of the X final amplifier are connected to the X-deflection plates of the C.R.T.

3.1.4. Cathode-ray tube circuit

The cathode-ray tube circuit comprises the C.R.T. itself and the brightness, focus, astigmatism, geometry and trace rotation controls and the beam blanking amplifier. A block diagram of the C.R.T. circuit is given in Fig. 3.10.

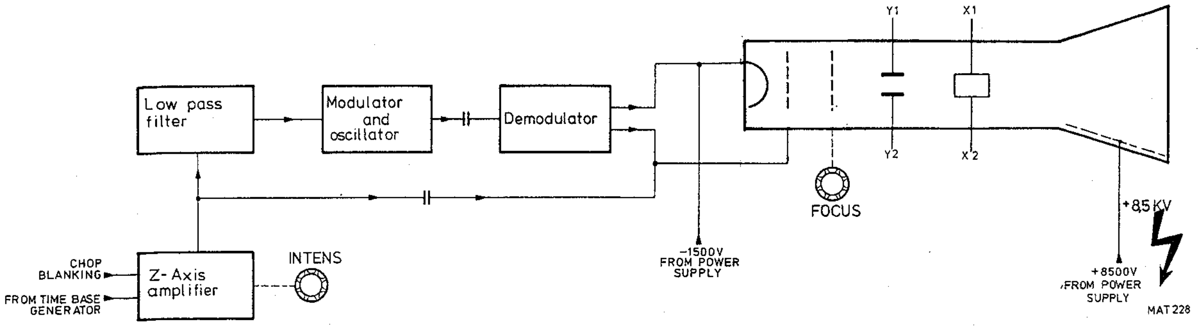
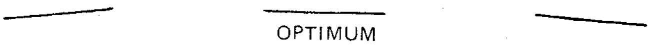


Fig. 3.10. Cathode-ray tube circuitry

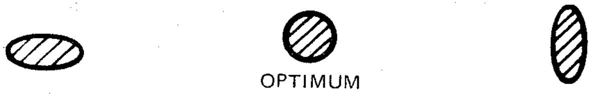
3.1.4.1. C.R.T. controls

By means of the INTENS potentiometer R1, the brightness of the display can be continuously controlled.
The display can be focused by means of the FOCUS potentiometer R6. Both INTENS and FOCUS controls are front panel controls.
Furthermore the C.R.T. circuitry comprises preset potentiometers for trace rotation, astigmatism and geometry.
The FOCUS control R6 forms a part of a voltage divider network across the 1.5 kV output of the power supply.
The slider of this potentiometer is connected direct to the focus, grid G3.

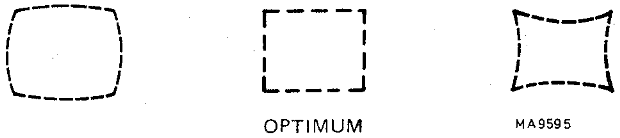
TRACE ROTATION is achieved by means of the trace rotation coil L1501. This coil mounted inside the mu-metal screen, provides a magnetic field for rotational control of the entire scan. The degree and direction of rotation is determined by the setting of front panel potentiometer R10 (screwdriver operated). The slider of R10 is connected to the bases of the complementary transistors V1521 and V1522.
The trace rotation coil L1501 is supplied by these transistors.



With the ASTIGMATISM control R1543, the form of the spot can be adjusted by influencing the voltage on the grids G2 and G4.



With the GEOMETRY control R1549 the barrel and pin-cushion distortion is corrected by influencing the voltage on the grid G7.



3.1.4.2. *Beam blanking amplifier*

The beam blanking amplifier receives two input signals. One signal originates in the time-base generator and is applied to the amplifier to unblank the trace during the sweep.
The other one is supplied by the channel switch to blank the trace during switching from channel to channel in the chop mode.
The INTENS potentiometer R1 determines the amount of input current fed to the amplifier.

In all the time/div. positions of the TIME/DIV switch S10, the anode of diode V1202 is kept at approx. +12 V, resulting in a logic 1 level at input 1 of NAND D1203.
The output point 12 of this NAND is now at logic 1 level when either input 2 or input 3 is low. In other words only during a sweep.
In the X DEFL position of the TIME/DIV switch S10, input 1 of NAND D1203 is at a logic 0 level, and in that case the output point 12 of this NAND is steady at logic 1 level. This output signal is inverted by a NAND and fed via diodes V1501 to diodes V1502 and V1503 of the beam blanking amplifier.
The chop mode blanking signal from the channel switch is fed to transistor V1506 via R1502. The inverted and amplified signal is applied to diode V1508.
Both signals are joined together at the base of transistor V1514 (point A in figure 3.11.). This is the virtual earth point of a shunt feedback amplifier.

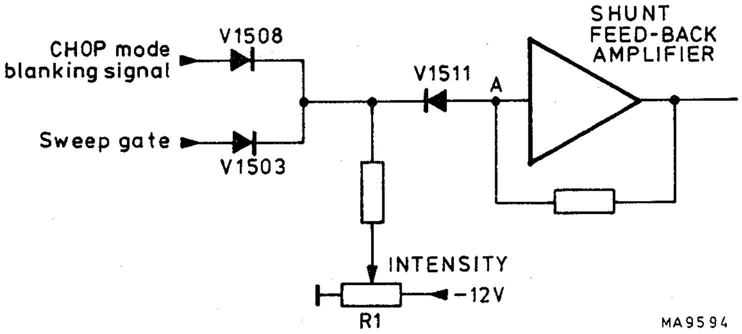


Fig. 3.11. Shunt feed back amplifier

Assume that V1503 and V1508 are turned-off by applying a logic zero to both inputs.
Then the output voltage of the amplifier can be varied with the aid of INTENS potentiometer R1. The light on the screen is variable then e.g. during a sweep or in the X deflection mode. A logic 1 on either one or both inputs of the diodes V1503 and V1508 turns V1511 off. The C.R.T. is then blank e.g. between sweeps or during the sweep when there is channel switching in the chop mode.

The blanking signal is amplified in the stage with transistors V1512, V1513 and V1514. At the output of this amplifier the a.c. and d.c. components of the blanking signal are guided along different paths. The a.c. path runs straight to the Wehnelt cylinder of the C.R.T. via capacitor C1512.
A d.c. signal is fed to the emitter of transistor V1517 via a low-pass filter R1528/C1508/R1527. Transistor V1517 constitutes a multivibrator together with transistor V1516. The a.c. voltage on the collector of V1517 has a peak-to-peak value which depends on the voltage fed to the emitter of V1516 by the shunt feed-back amplifier.

The a.c. voltage supplied by multivibrator V1516/V1517 is applied to a peak detector. This peak detector rectifies this a.c. voltage.

The reason for the a.c. and d.c. paths is isolation of the cathode and Wehnelt cylinder, which are on a −1,5 kV potential, from the other circuits. The a.c. component of the blanking signal is transmitted straight away to the high-voltage part via blocking capacitor C1512, which is a high voltage capacitor. The d.c. signal, however, is converted into an a.c. voltage and then transmitted to the high-voltage part, via capacitor C1509, after which it is rectified by means of diode V1519.
The dark level can be adjusted with the aid of potentiometer R1534 in the emitter circuit of transistor V1517 in the d.c. amplifier.

3.1.5. Power supply

The power supply comprises a mains transformer and rectifier, a DC to AC converter regulator and a transformer and output voltage rectifier.
The power supply also incorporates a circuit for the graticule illumination.

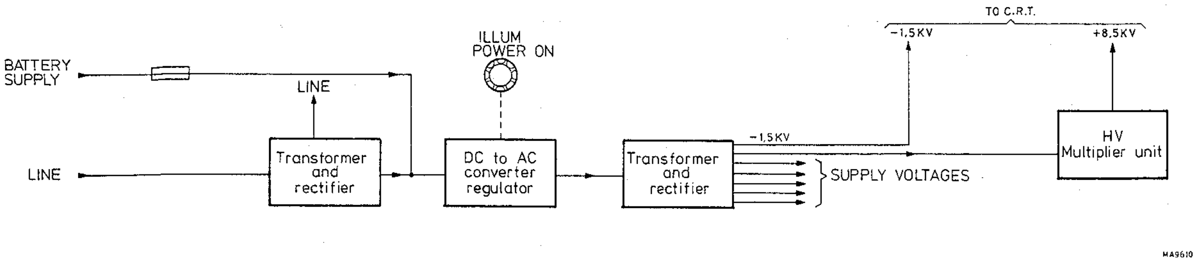

BATTERY SUPPLY
LINE
LINE
Transformer and rectifier
ILLUM POWER ON
DC to AC converter regulator
Transformer and rectifier
-1.5KV
SUPPLY VOLTAGES
TO C.R.T.
-1.5KV
+8.5KV
HV Multiplier unit
MA9610

Fig. 3.12. Power supply

The line part of the PM 3212 power supply is double insulated and meets IEC 348 SAFETY CLASS II recommendations for metal-encased electrical equipment. This eliminates the need for a 3-wire power cord with earth connection.
The converter together with the primary of the converter transformer is electrically floating in relation to mass. Therefore also the 24 V d.c. supply is floating.

3.1.5.1. Mains transformer

An incoming mains voltage is fed via the thermal fuse (F101) and the voltage selector S18 to the appropriate primary taps on the mains transformer T101. Transformer T101 has three primary windings which can be combined by means of voltage adapter S18. This combination allows the instrument to be used with mains voltages of 110 V, 127 V, 220 V and 240 V.

The voltage on the secundary windings of this transformer is full-wave rectified. The resulting negative d.c. voltage (approx. 24 V) across electrolytic capacitor C203, or alternatively a negative d.c. voltage on the rear panel DC POWER IN input socket X7, is applied to the voltage stabilizer and converter.

Part of the a.c. voltage on the secundary winding of the mains transformer is fed via C201, R373 and R372 to LINE trigger source selector switch S16A, to enable internal triggering on the line frequency.

3.1.5.2. Converter and stabilized power supply

The converter is a square-wave generator operating at a frequency of approx. 18 kHz and driven by the d.c. voltage across the electrolytic capacitor C203.
A basic diagram of the converter is shown in Fig. 3.13.

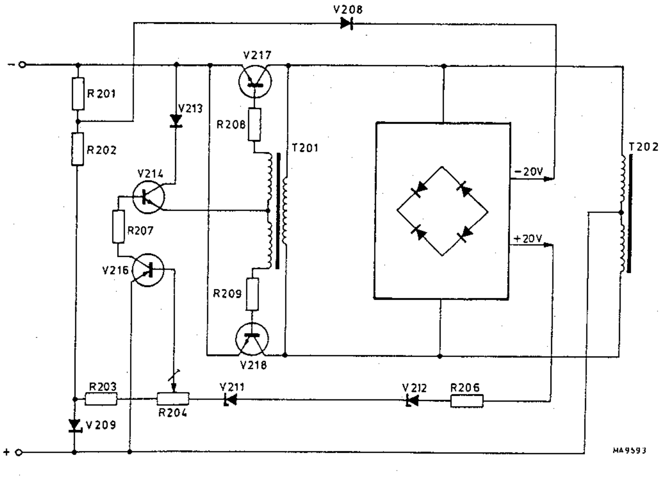

V208
-
V217
R201
V213
R208
T201
T202
R202
V214
-20V
R207
+20V
V216
R209
V218
R203
V211
V212
R206
R204
V209
+
MA9593

Fig. 3.13. Basic diagram of the converter

In the converter, transistors V217 and V218 function as switches and regulators and alternately connect the negative supply voltage to either end of the primary of T201/T202. Assume that transistor V217 has a slightly higher current gain than V218. Then the positive voltage from the feedback winding quickly drives transistor V217 into saturation. The current in the top half of the primary of T201/T202 increases linearly at a rate determined by the inductance of the primary. This current increase continues until the iron in transformer coil T201 is saturated.
Then the magnetic lines of flux stop changing and consequently no voltage is induced any longer in the feedback winding. When its base drive ceases, the transistor is cut off.
This reverses the polarity of the feedback voltage and transistor V218 is turned hard on. The bottom half of the primary then passes an increasing current until the core is saturated in the opposite direction.
The subsequent absence of feedback voltage initiates the switching back to V217 and the cycle starts again.

The regulation works as follows. When an input voltage is applied to the converter, the negative voltage across Zener diode V209 turns transistor V216 fully on, as there is no positive voltage from temperature compensation stabistors V211 and V212.
Then a bias current flows via transistor V216 through resistor R207, through the base-emitter junction of transistor V214 (operating as a diode since diode V213 interrupts the collector circuit) and from base to emitter of both transistors V217 and V218.
As there is then an a.c. voltage across the primary of T201/T202, diodes V222 and V223 produce a positive d.c. voltage of +20 V across capacitor C209. This voltage reduces the current through transistors V216 and V214 sufficiently to limit the drive to transistors V217 and V218 and produce the desired output level.
The setting of potentiometer R204 determines the value of the regulated output voltage. Possible differences from the set output voltage are fed back via the temperature compensation stabistors V211 and V212 to transistor V216 so that the drive of transistors V217 and V218 is adapted so as to compensate for the differences. This also applies to mains voltage fluctuations.

After rectifying and smoothing, the secundary voltages +5 V, +12 V, −12 V, +38 V, +180 V, −180 V, −1500 V and post acceleration voltage +8500 V are obtained. The voltage quintupler which supplies the +8500 V cannot be repaired and must be replaced when it breaks down.
T202 contains a separate secundary winding for the heater voltage for the C.R.T..
All supply voltages except the +8500 V and the −1500 V can be continuously short-circuited without damage to the components. Resistor R202 limits the collector current when the output is short-circuited and the switching action is stopped, thereby holding the dissipated power in transistors V217 and V218 at a safe level.
Thus, the power supply of the oscilloscope is fully protected against short-circuits. A short-circuit is indicated either by a squeeking noise coming from the power supply or by the pilot lamp B1, which indicates the ON state of the oscilloscope, failing to light up.
If supplied by an external d.c. voltage, the instrument is protected against overloads and wrong polarity by internal fuse F201 and diode V206.

3.1.5.3. Illumination circuit

The graticule of the C.R.T. can be illuminated by means of the bulbs E1. The intensity can be varied with the aid of ILLUM potentiometer R11 which controls the collector current (which is the current through the bulbs) of transistor V207. The illumination circuit is not short-circuit proof.

3.1.6. Calibration unit

The calibrator circuit consists of transistors V1602 and V1603, which are configurated as a stable multivibrator such as used in the channel switch. Good shape of the wave-form is obtained by a constant current supplied by transistor V1602 which will flow in turns through the left hand or right hand transistor. The amplitude is 1,2 V or 6 div in the 20 mV/div attenuator positions. (The straight through position of the attenuator.)
Potentiometer R1607 allows accurate adjustment of the amplitude of the calibrator output voltage. This square-wave output voltage is taken off from the collector of transistor V1603 and fed to socket X1. This is the front panel CAL terminal.
The calibrator output signal can be used for probe compensation and/or checking the vertical deflection accuracy.

TEST EQUIPMENT AND TOOLS REQUIRED

For a complete checking and adjusting procedure, you will need the tools and test-equipment, listed in the following table.

TEST EQUIPMENT

Description of the instrument	*Specification of the test instrument*	*Suitable test instrument*	*Usage*
Digital multimeter	AC/DC instrument, accuracy within 0.1 %	PHILIPS PM 2522A or equivalent	Power supply, C.R.T. circuit. Trouble shooting
Time marker generator	Providing markers of 2 μs to 0.2 μs, accuracy within 0.5 %	–	Time-base timing checks
T.V. pattern generator or T.V. source	Providing frame and line synchronisation output amplitude at least 40 mV	PHILIPS PM 5509 or equivalent	Time-base T.V. triggering
Square-wave generator	Providing output voltages variable from 10 mV to 12 V, accuracy within 0.5 %. Frequency range 2 kHz – 1 MHz. Rise time ⩽ 3 ns	–	Attenuator response, vertical gain and response checks.
Sinewave generator	Providing output voltages variable from 10 mV to 10 V, frequency range 20 Hz ... 35 MHz	PHILIPS PM 5167 suitable for most purposes	Vertical amplifier bandwidth and triggering checks Trouble shooting
Monitor oscilloscope	0 – 35 MHz bandwidth	PHILIPS PM 3216 or equivalent	Trouble shooting
Ampere-meter	Moving-iron meter	–	Mains current consumption
Variable mains transformer	Well insulated for safe checking	PHILIPS 2422 529 00005	Power supply Trouble shooting
Probe 10x attenuation	Suitable for input capacities of 15 pF to 40 pF	PHILIPS PM 8925 or equivalent	Trouble shooting
Trimming tool kit	Low capacitance trimming tool	PHILIPS see Fig. 3.30.	Adjusting and maintenance

Fig. 3.14. Test equipment and tools required.

3.2. CHECKING AND ADJUSTING

3.2.1. General information

All adjusting elements have been listed in the headings of the various sections. For required test equipment and tools see Fig. 3.14. Allow a warming-up time of 30 minutes before checking and adjusting.

DO NOT READJUST ANY PART OF THE INSTRUMENT BEFORE YOU HAVE CHECKED THE NECESSITY OF THIS READJUSTMENT! !

3.2.2. Power supply

3.2.2.1. Mains current

- Check that the mains voltage adapter (S18) has been set to the **local** mains voltage and connect the instrument to such a voltage.
- Switch the oscilloscope on and check that the pilot lamp on the front panel lights up.
- Check that the current consumption does not exceed 150 mA at 220 V local mains and 300 mA at 117 V local mains. (Measured with a moving iron meter.)

3.2.2.2. Supply voltages (R204)

- Check that the voltage across capacitor C224 is +12 V, + or –0,25 V; if necessary readjust potentiometer R204 (Fig. 3.15).
- Check the supply voltages in accordance with the following table:

Voltage across	*Required value*	*Max. allowable ripple*
C227 (Fig. 3.15)	+5 V, ± 0,2 V	⩽ 2 mVp-p
C224 (Fig. 3.15)	+12 V, ± 0,25 V	⩽ 4 mVp-p
C229 (Fig. 3.15)	–12 V, ±0,25 V	⩽ 4 mVp-p
C222 (Fig. 3.15)	+38 V, ± 2 V	⩽ 40 mVp-p
C231 (Fig. 3.15)	–180 V, ± 9 V	⩽ 1 Vp-p
C221 (Fig. 3.15)	+180 V, ± 9 V	⩽ 1 Vp-p
C211 (Fig. 3.15)	6.3 V, ± 0,6 V	

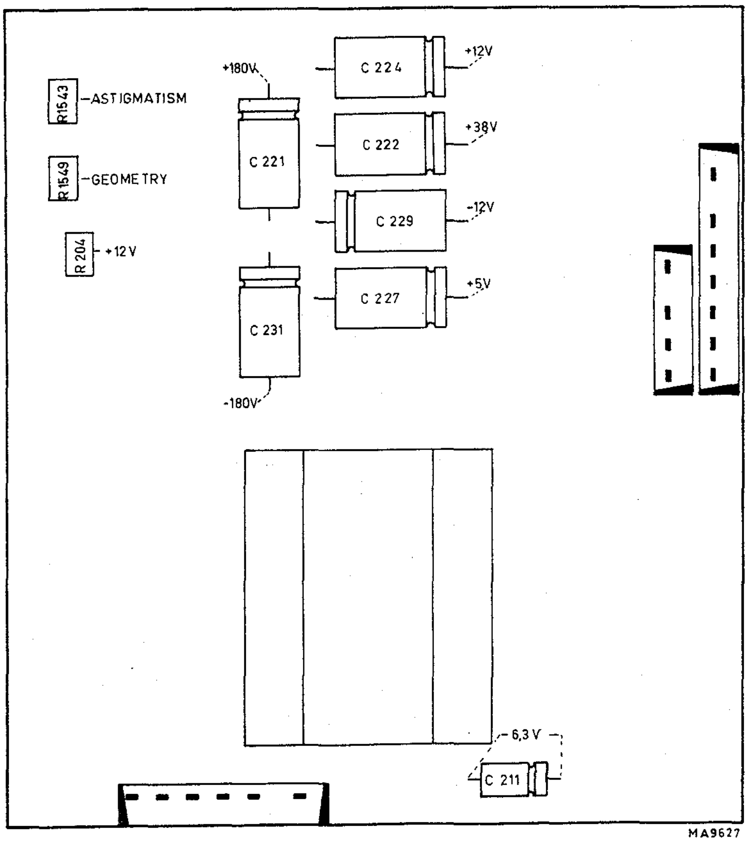


Fig. 3.15. Adjusting and checking the power supply

- Vary the a.c. voltage to which the instrument is connected with + or −10 % of the nominal voltage.
- Check that the supply voltages do not vary more than ± 2 ‰ and that the ripple voltages do not exceed the values mentioned in the table above.

3.2.3. Cathode-ray tube circuit

3.2.3.1. Brilliance (R1534)

- Depress push button A of the display mode switch S1.
- Set TIME/DIV switch S10 to position EXT X DEFL.
- Depress push button EXT of the trigger source selector switch S16.
- Set A POSITION potentiometer R2 and X POSITION potentiometer R4 to their mid-positions.
- Set INTENS potentiometer R1 to 90° from its left hand stop.
- Adjust potentiometer R1534 (Fig. 3.17) in such a way that the spot is just not visible.

3.2.3.2. Trace rotation (R10)

- Depress push button AUTO of the trigger mode switch S2.
- Set TIME/DIV switch S10 to 0.1 ms/div.
- Depress push button A of the display mode switch S1.
- Depress push button A of the trigger source selector switch S16.
- Depress the input coupling switch S13 (0).
- Center the time-base line using A POSITION potentiometer R2.
- Check that the time-base line runs exactly in parallel with the horizontal lines of the graticule. If necessary, readjust front panel TRACE ROTATION potentiometer R10.

3.2.3.3. Focus and astigmatism (R1543)

- Depress push button A of the display mode switch S1.
- Depress push button A of the trigger source selector switch S16.
- Depress the input coupling switch S12 (AC).
- Release the input coupling switch S13 (0).
- Set A AMPL/DIV switch S6 to 0.1 V/div and A AMPL/DIV potentiometer R7 to CAL.
- Set TIME/DIV switch S10 to 50 μs/div and TIME/DIV potentiometer R9 to CAL.
- Apply a sine-wave voltage of approx. 600 mVp-p, 10 kHz, to the A input socket X2.
- Set INTENS potentiometer R1 for normal brightness.

Use an insulated screw-driver.

- Adjust FOCUS potentiometer R6 and astigmatism potentiometer R1543 for a sharp and well-defined trace (Fig. 3.15).

3.2.3.4. Geometry (R1549)

- Set the controls as in the previous section.
- Set A AMPL/DIV switch S6 to 5 mV/div and A AMPL/DIV potentiometer R7 to CAL.
- Apply a sine-wave voltage of approx. 600 mVp-p, 10 kHz, to the A input socket X2.

Use an insulated screw-driver.

- Check that the displayed vertical lines are as straight as possible. If necessary readjust potentiometer R1549 (Fig. 3.15).

3.2.4. Y-amplifier balance

3.2.4.1. General information

The adjustments of the vertical amplifier channels A and B are identical. The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A.

3.2.4.2. *D.C. balance (R504, R604)*

- Depress push button A (B) of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Depress the input coupling switch S13 (S15) (0).
- Set AMPL/DIV potentiometer R7 (R8) to CAL.
- Centre the trace using A (B) POSITION potentiometer R2 (R3).
- Check that the trace does not jump if AMPL/DIV switch S6 (S8) is switched from 10 mV/div to 20 mV/div. If necessary, adjust potentiometer R504 (R604) for minimum jump (Fig. 3.17).
- Repeat the measurement for channel B.

3.2.4.3. *Gain balance (R514, R614)*

- Depress push button A (B) of the display mode switch S1.
- Depress the input coupling switch S13 (S15) 0.
- Check that the trace does not move when the AMPL/DIV potentiometer R7 (R8) is rotated. If necessary readjust R514 (R614) (Fig. 3.17).
- Repeat the measurement for channel B.

3.2.4.4. *Normal/invert balance channel B (R647)*

- Depress push button B of the display mode switch S1.
- Depress the input coupling switch S15 (0).
- Check that the trace does not jump when PULL TO INVERT B switch S4 is switched between normal and invert. If necessary readjust R647 (Fig. 3.17).

3.2.4.5. *Shift balance (R547, R674)*

- Depress push button A (B) of the display mode switch S1.
- Depress push button A (B) of the trigger source selector switch S16.
- Depress the input coupling switch S12 (S14) (AC).
- Release the input coupling switch S13 (S15) (0).
- Set the AMPL/DIV switch S6 (S8) to 20 mV/div and AMPL/DIV potentiometer R7 (R8) to CAL.
- Set the TIME/DIV switch S10 to 50 μs/div and TIME/DIV potentiometer R9 to CAL.
- Apply a sine-wave voltage of 480 mVp-p, 10 kHz to the A (B) input socket.
- Check if the extremes of the sine-wave can be displayed distortion free on the screen by rotating the POSITION potentiometer R2 (R3).
  If necessary readjust potentiometer R547 (R674) (see Fig. 3.17.).
- Repeat the measurement for channel B.

3.2.5. **Trigger balance (R356, R358, R361)**

- Depress push button A of the display mode switch S1.
- Set X MAGN switch S5 to position X1.
- Set TIME/DIV switch S10 to 0.1 ms/div and TIME/DIV potentiometer R9 to CAL.
- Depress push button AUTO of the trigger mode switch S2.
- Set X POSITION potentiometer R4 in such a way that the time base line starts at the most left graticule line.
- Set TIME/DIV switch S10 to X DEFL.
- Depress push button EXT of the trigger source selector switch S16.
- Check that the spot lies in the center of the screen; tol. 1 div.
- Depress push button A of the trigger source selector switch S16.
- Depress push button DC of the trigger mode switch S2.
- Check that the spot lies in the center of the screen.
  If necessary readjust potentiometer R356 (Fig. 3.16).
- Depress push button B of the trigger source selector switch S16.
- Check that the spot lies in the center of the screen.
  If necessary readjust potentiometer R361 (Fig. 3.16).
- Depress both A and B push buttons (composite) of the trigger source selector switch S16.
- Shift the spot to the central horizontal graticule line using A POSITION potentiometer R2.
- Check that the spot lies in the center of the screen.
  If necessary readjust potentiometer R358 (Fig. 3.16).

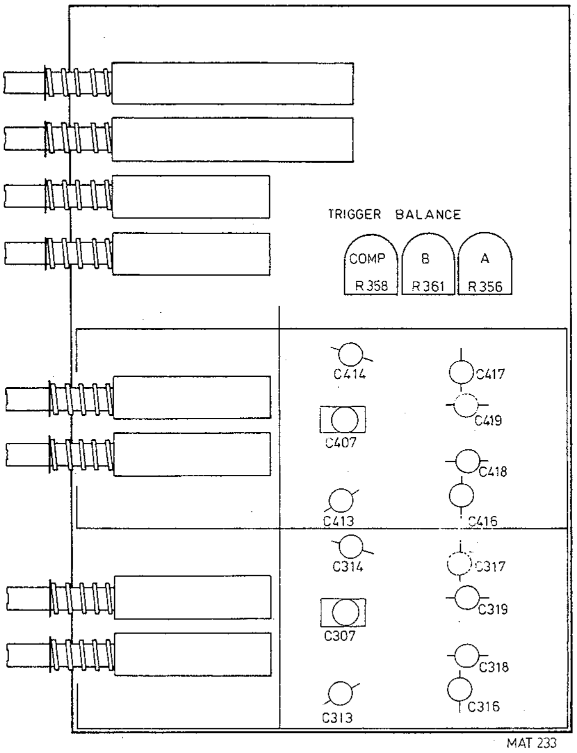


Fig. 3.16. Adjusting elements attenuator board

3.2.6. Time coefficients (R1417, R1419, R1232)

- Depress push button A of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Set X MAGN switch S5 to position X1.
- Set A AMPL/DIV switch S6 to 20 mV/div.
- Release the input coupling switch S13 (0).
- Depress push button A of the trigger source selector switch S16.
- Set TIME/DIV switch S10 to 2 μs/div and TIME/DIV potentiometer R9 to CAL.
- Apply a time marker voltage with repetition time of 2 μs and an amplitude of 80 mVp-p to the A input socket X2.
- Check that the central 8 cycles occupy 8 divisions.
  If necessary readjust potentiometer R1417 (Fig. 3.17).
- Pull X MAGN switch S5 to position X10.
- Change the repetition time of the applied input signal to 0.2 μs.
- Check that the central 8 cycles occupy 8 divisions.
  If necessary readjust potentiometer R1419 (Fig. 3.17).
- Check that the trace can be shifted over 100 divisions with the aid of X-POSITION potentiometer R4.
- Push X MAGN switch S5 to position X1.
- Set TIME/DIV switch S10 to 5 ms/div.
- Change the repetition time of the applied input signal to 5 ms.
- Check that the central 8 cycles occupy 8 divisions.
  If necessary readjust potentiometer R1232 (Fig. 3.17).
- Check all the other positions of the TIME/DIV switch S10. The repetition time of the applied input signal should correspond to the position of the TIME/DIVISION switch S10.
  The central 8 cycles should always occupy 8 divisions: tolerance ± 1 subdivision (2 subdivisions with X MAGN switch S5 to position x10).
- Check that in all the positions of the TIME/DIV switch S10 the time-base length is at least 10 divisions.
- Check the control range of the TIME/DIV potentiometer R9 in the position 0.1 ms/div of the TIME/DIV switch S10. This should be: 1 : $\geqslant 2.5$.

3.2.7. Vertical amplifiers

3.2.7.1. *General information*

The adjustments of the vertical amplifier channels A and B are identical. The knobs, sockets and adjusting elements of channel B are shown in brackets after those of channel A.

3.2.7.2. *Deflection sensitivity (gain)*

The adjustments of the vertical amplifier sensitivity must follow the specified sequence.

Channel B	X1	Gain	(R848)
Channel A	X1	Gain	(R543)
Channel B	X10	Gain	(R621)
Channel A	X10	Gain	(R521)

Deflection sensitivity X1 (R848, R543)

- Depress push button B (A) of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Depress push button B (A) of the trigger source selector switch S16.
- Set AMPL/DIV potentiometer R8 (R7) to CAL.
- Release input coupling switch S14 (S12) (DC).
- Release input coupling switch S15 (S13) (0).
- Set TIME/DIV switch S10 to 0.2 ms/div.
- Set AMPL/DIV switch S8 (S6) to 20 mV/div.
- Apply a square-wave voltage of 120 mV, frequency approx. 2 kHz, to the B (A) input socket.
- Check that the signal occupies 6 divisions.
  If necessary readjust potentiometer R848 (R543) (Fig. 3.17).
- Repeat the measurement for channel A.

Deflection sensitivity X10 (R621, R521)

- Depress push button B (A) of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Depress push button B (A) of the trigger source selector switch S16.
- Set AMPL/DIV potentiometer R8 (R7) to CAL.
- Release input coupling switch S14 (S12) (DC).
- Release input coupling switch S15 (S13) (0).
- Set TIME/DIV switch S10 to 0.2 ms/div.
- Set AMPL/DIV switch S8 (S6) to 2 mV/div.
- Apply a square-wave voltage of 12 mVp-p, frequency approx. 2 kHz, to the B (A) input socket.
- Check that the signal occupies 6 divisions.
  If necessary readjust R621 (R521) (Fig. 3.17).

Repeat the measurement for channel A.

3.2.7.3. *Input attenuators*

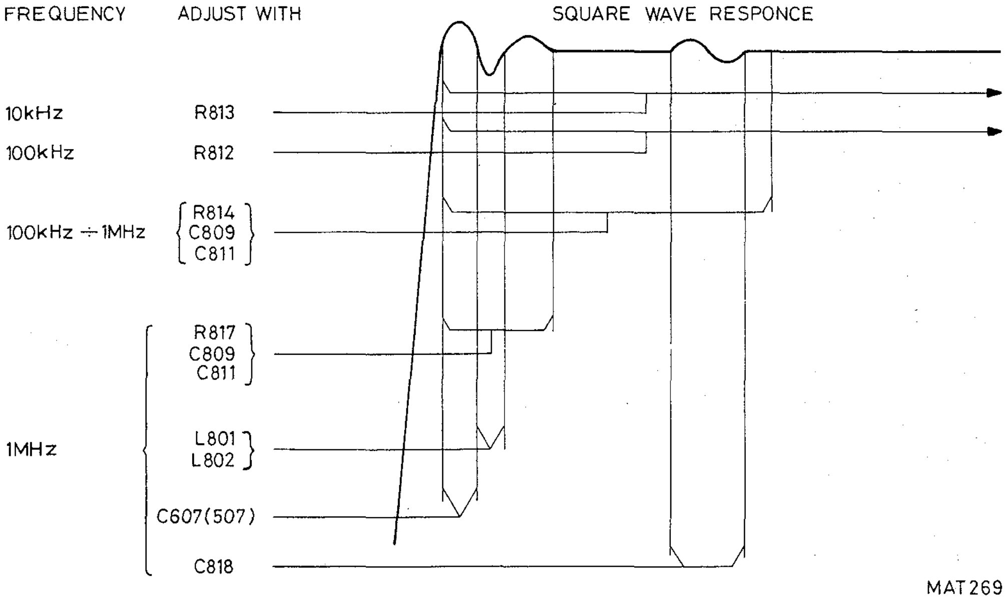
- Depress push button A (B) of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Depress push button A (B) of the trigger source selector switch S16.
- Set TIME/DIV switch S10 to 0.2 ms and the TIME/DIV potentiometer R9 to CAL.
- Release input coupling switch S12 (S14) (DC).
- Release input coupling switch S13 (S15) (0).
- Set AMPL/DIV potentiometer R7 (R8) to CAL.
- Apply a square-wave voltage with an amplitude as indicated in the following table, a repetition rate of approx. 2 kHz and a rise time ≤ 100 ns, to the A (B) input socket.
- Check that no overshoot is visible (max. pulse top errors 2 %), and check that the trace height is 6 divisions ± 3 % (1 subdivision).

S6 (S8) ampl. to	Input signal	Adjust with
20 mV	120 mV	C307 (C407)
50 mV	.3 V	C313 (C413)
.1 V	.6 V	C314 (C414)
.2 V	1.2 V	C316+C318 (C416+C418)
2 V	12 V	C317+C319 (C417+C419)

- Repeat the measurement for channel B.

3.2.7.4. *Square-wave response final amplifier*

- Depress push button B of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Depress push button B of the trigger source selector switch S16.
- Push NORMAL/INVERT switch S4 to position NORMAL.
- Set B AMPL/DIV switch S8 to 20 mV/div and B AMPL/DIV potentiometer R8 to CAL.
- Apply a square-wave voltage of approx. 120 mVp-p, with rise time ⩽ 3 ns, to the B input socket. The pulse repetition should be in accordance with the table below.
- Check the square-wave response, pulse top errors may not exceed 1 subdivision.
- Check that the rise time does not exceed 14 ns.



* L801 and L802 should be operated simultaneously and in the same direction and by the same amount. If necessary repeat above adjustments *until the best response is obtained.*

- Check and readjust the square-wave response according to the table below.

Channel	Ampl/div	Input signal	Trace height	Rep.rate	Time/div	Adj. with	Max. error
B	2 mV/div	12 mV	6 div.	1 MHz	. 2 μs	C602	1 subdivision
A	20 mV/div	120 mV	6 div.	1 MHz	. 2 μs	C508	1 subdivision
A	2 mV/div	12 mV	6 div.	1 MHz	. 2 μs	C502	1 subdivision

3.2.7.5. *Cross talk (R813)*

- Depress push button CHOP of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Depress push button B of the trigger source selector switch S16.
- Push NORMAL/INVERT switch S4 to position NORMAL.
- Set A and B AMPL/DIV switches S6 and S8 to 20 mV/div and the AMPL/DIV potentiometer R7 and R8 to CAL.
- Set the TIME/DIV switch S10 to 0.5 ms/div and the TIME/DIV potentiometer R9 to CAL.
- Depress the input coupling switch S13 (0).
- Apply a square-wave voltage of 120 mVp-p, rise time ⩽ 3 ns and a repetition rate of approx. 10 kHz to the B input socket.
- Adjust potentiometer R813 (Fig. 3.17) for minimum cross talk between both channels.

3.2.7.6. *Bandwidth check of channel A (B)*

- Depress push button A (B) of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Depress push button A (B) of the trigger source selector switch S16.
- Set TIME/DIV switch S10 to 0.1 ms/div and the TIME/DIV potentiometer R9 to CAL.
- Set AMPL/DIV switch S6 (S8) to 2 mV/div and AMPL/DIV potentiometer R7 (R8) to CAL.
- Release input coupling switch S12 (S14) (DC).

- Release input coupling switch S13 (S15) (0).
- Apply a sine-wave signal of 12 mVp-p, frequency approx. 100 kHz to the A (B) input socket.
- Increase the frequency of the input signal to 35 MHz, the amplitude of the signal must remain 12 mV.
- Check that the trace height is at least 4.2 divisions at input frequency of 35 MHz.

Repeat the measurement for channel B.

3.2.8. Triggering

3.2.8.1. Trigger slope (R1014)

- Depress push button A of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Depress push button A of the trigger source selector switch S16.
- Depress input coupling switch S13 (0).
- Set LEVEL potentiometer R5 to its midposition.
- Check with a multimeter that the DC output voltage of the trigger amplifier (collector of V1014) does not change if SLOPE push button S3 is switched between + and –.
  If necessary readjust potentiometer R1014 (Fig. 3.17).
- Set AMPL/DIV switch S6 to 20 mV/div and AMPL/DIV potentiometer R7 to CAL.
- Release input coupling switch S12 to (DC).
- Release input coupling switch S13 (0).
- Apply a sine-wave signal of 120 mVp-p, frequency approx. 2 kHz, to the A input socket.
- Set TIME/DIV switch S10 to 0.2 ms/div.
- Release SLOPE switch S3 to the + position and check that the trace starts with a positive going edge.
- Depress SLOPE switch S3 to the – position and check that the trace starts with a negative going edge.

3.2.8.2. Trigger sensitivity (R1041)

- Set the controls as on the previous section.
- Apply a sine-wave signal of 120 mVp-p, frequency approx. 2 kHz to the A input socket.
- Find the lowest possible input signal at which it is still possible to obtain a triggered trace with the aid of LEVEL potentiometer R5 and potentiometer R1041 (Fig. 3.17).

3.2.8.3. Trigger level internal DC

- Depress push button A of the display mode switch S1.
- Depress push button DC of the trigger mode selector switch S2.
- Depress push button A of the trigger source selector switch S16.
- Apply a sine-wave signal for a trace height equivalent of 16 divisions to the A input socket.
- Check that the starting point of the sine-wave can be shifted across 16 divisions with the aid of LEVEL potentiometer R5.
- Enlarge the vertical deflection to 24 divisions and check that the level range of R5 does not exceed 24 divisions.

3.2.8.4. Trigger level auto

- Depress push button A of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Depress push button A of the trigger source selector switch S16.
- Release input coupling switch S13 (0).
- Apply a sine-wave voltage at a frequency of approx. 100 Hz for 6 divisions trace height to the A input socket.
- Check that the starting point of the sine-wave can be shifted across approx. 3 divisions with the aid of LEVEL potentiometer R5.

3.2.8.5. Trigger level external

- Depress push button A of the display mode switch S1.
- Depress push button AC of the trigger mode switch S2.
- Depress push button EXT of the trigger source selector switch S16.
- Release input coupling switch S12 (DC).
- Release input coupling switch S13 (0).

- Set A AMPL/DIV switch S6 to 1 V/div and A AMPL/DIV potentiometer R7 to CAL.
- Set TIME/DIV switch S10 to 0.2 ms/div. and TIME/DIV potentiometer R9 to CAL.
- Apply a sine-wave signal of 8 Vp-p, frequency approx. 2 kHz to the A and EXT input sockets.
- Check that the starting point of the sine-wave can be shifted across the entire amplitude of the signal with the aid of LEVEL potentiometer R5.

3.2.8.6. Trigger sensitivities

- Check the trigger sensitivity in accordance with the table below or better.

Trigger source S16	Trigger mode S2	+/– S3	Trace height or ampl.	Signal to	Freq.	Shape	Ampl. input voltage
A	Auto	+	1 div.	X2 (YA)	100 Hz	Sine	20 mVp-p
A	Auto		1 div.	X2 (YA)	10 kHz	Sine	20 mVp-p
A	Auto		1 div.	X2 (YA)	35 MHz	Sine	28 mVp-p
A	AC		1 div.	X2 (YA)	20 Hz	Sine	20 mVp-p
A	AC		1 div.	X2 (YA)	35 MHz	Sine	28 mVp-p
A	DC		1 div.	X2 (YA)	35 MHz	Sine	28 mVp-p
B	DC		1 div.	X3 (YB)	20 Hz	Sine	20 mVp-p
B	DC		1 div.	X3 (YB)	35 MHz	Sine	28 mVp-p
A+B	DC		1 div.	X3 (YB)	35 MHz	Sine	28 mVp-p
A+B	DC			X2 (YA)	± 2 kHz	Square *	± 20 mVp-p
(comp)				X3 (YB)	± 2 kHz	Sine *	± 20 mVp-p
(S1 in ALT)							
B	TV	+	0.7 div. Sync. pulse	X3 (YB)		+ Video	14 mVp-p Sync. pulse
B	TV	–	0.7 div. Sync. pulse	X3 (YB)		– Video	14 mVp-p Sync. pulse
B	TV	–	± 2 div. Sync. pulse	X3 (YB)		– Video	± 40 mVp-p Sync. pulse
EXT	DC		0,2 Volt	X4 (EXT)	20 Hz	Sine	0,2 Vp-p
					35 MHz	Sine	0,2 Vp-p
EXT ÷ 10	DC		2 Volt	X4 (EXT)	20 Hz	Sine	2 Vp-p
					35 MHz	Sine	2 Vp-p

* Originating from different sources.

- Set LEVEL potentiometer R5 as required.
- Set TIME/DIV switch S10 to such a position that a reasonable number of sine-waves is displayed.
- Set A and B AMPL/DIV switches S6 and S8 to 20 mV/div. and the A and B AMPL/DIV potentiometers R7 and R8 to CAL.

3.2.8.7. Triggering on the line frequency

- Depress push button A of the display mode switch S1.
- Depress push button AUTO of the trigger mode switch S2.
- Depress push button B of the trigger source selector switch S16.
- Set TIME/DIV switch S10 to 5 ms/div and TIME/DIV potentiometer R9 to CAL.
- Set A AMPL/DIV switch S6 to 20 mV/div and A AMPL/DIV potentiometer R7 to CAL.
- Release input coupling switch S12 (DC).
- Release input coupling switch S13 (0).
- Apply a signal of approx. 10 mVp-p at the mains frequency to the A input socket.
  The trace is not triggered.
- Depress push button LINE of the trigger source selector switch S16 and check that the trace is triggered.

3.2.9. X Deflection

3.2.9.1. Sensitivity

- Set TIME/DIV switch S10 to X DEFL.
- Depress push button EXT of the trigger source selector switch S16.
- Apply a sine wave voltage of 4 Vp-p frequency approx. 10 kHz, to the EXT input socket.
- Check that the trace length is 8 divisions ± 0.8 division.

3.2.9.2. Frequency response

- Set TIME/DIV switch S10 to X DEFL.
- Depress push button EXT of the trigger source selector switch S16.
- Apply a sine-wave voltage of 4 Vp-p (trace length 8 divisions), frequency approx. 10 kHz, to the EXT input socket.
- Increase the frequency to 1 MHz.
- Check that the trace length is at least 5.6 divisions.

3.2.9.3. X Deflection with a line signal

- Set TIME/DIV switch S10 to X DEFL.
- Depress push button LINE of the trigger source selector switch S16.
- Check that the trace length is 8 divisions ± 1 division.

3.2.9.4. Horizontal sensitivity via input A

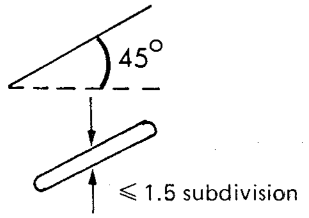
- Set A AMPL/DIV switch S6 to 20 mV/div and A AMPL/DIV potentiometer R7 to CAL.
- Depress push button B of display mode switch S1.
- Set TIME/DIV switch S10 to X DEFL.
- Depress push button A of the trigger source selector switch S16.
- Apply a sine wave voltage of 120 mVp-p, frequency approx. 2 kHz, to the A input socket.
- Check that the trace length is 6 divisions ± 0.6 division.

3.2.9.5. Horizontal sensitivity via input B

- Set B AMPL/DIV switch S8 to 20 mV/div and B AMPL/DIV potentiometer R8 to CAL.
- Depress push button A of display mode switch S1.
- Set TIME/DIV switch S10 to X DEFL.
- Depress push button B of the trigger source selector switch S16.
- Apply a sine wave voltage of 120 mVp-p, frequency approximately 2 kHz, to the B input socket.
- Check that the trace length is 6 divisions ± 0.6 division.

3.2.9.6. Phase difference between X and Y channels

- Input signal and control settings as in the previous section.
- Depress push button B of the display mode switch S1.
- Check that the line is displayed under an angle of 45°.
- Increase the frequency to 100 kHz.
- Check that the phase error does not exceed 3° division).


45°
⩽ 1.5 subdivision

3.2.10. Calibration voltage (R1607)

- Check that the voltage on the CAL output socket is 1.2 V ± 1 % If necessary readjust potentiometer R1607 (Fig. 3.17).

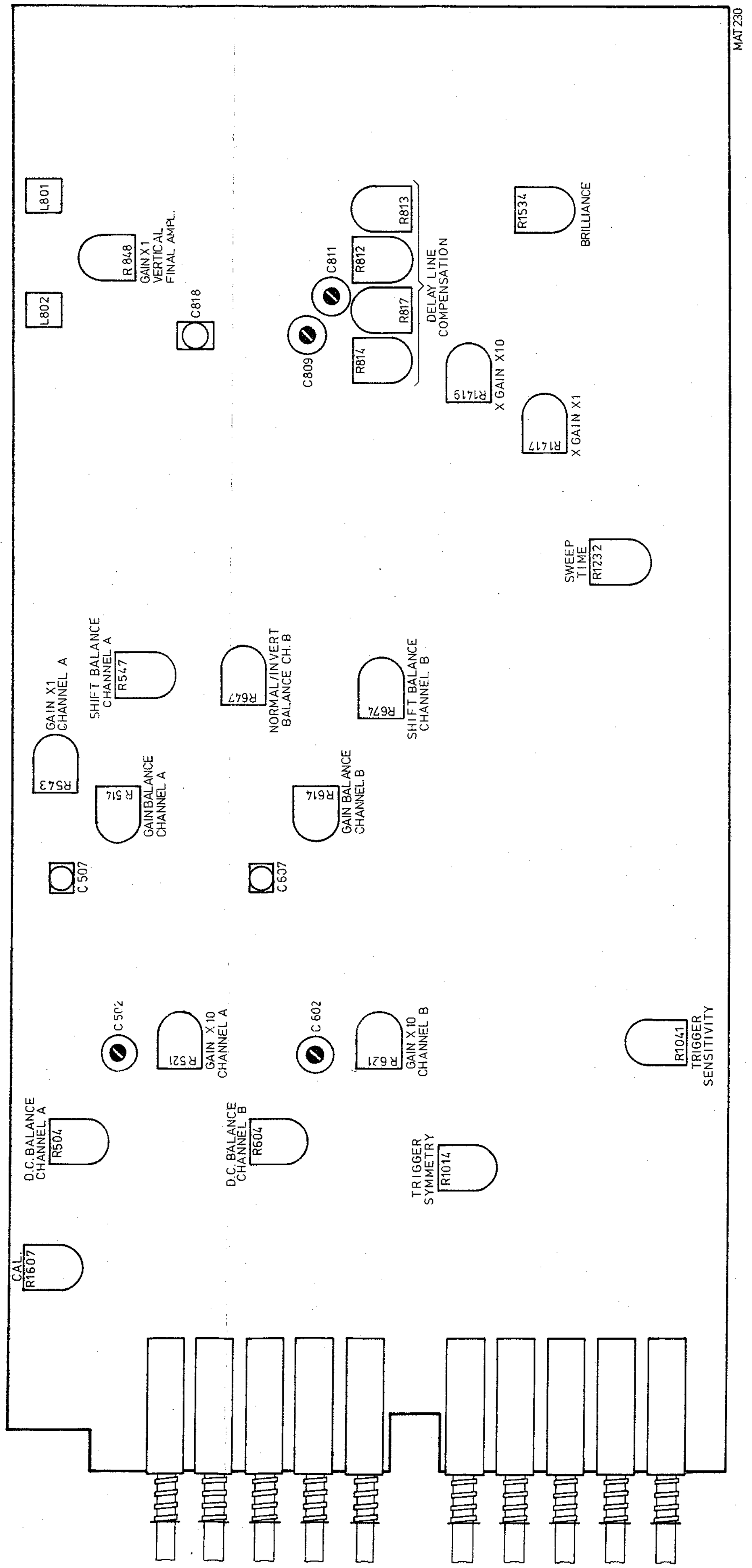

MAT 230
L801
L802
R 848
GAIN X1
VERTICAL
FINAL AMPL.
C818
C809
C811
R813
R812
R817
R814
DELAY LINE
COMPENSATION
R1534
BRILLIANCE
R1419
X GAIN X10
R1417
X GAIN X1
SWEEP
TIME
R1232
GAIN X1
CHANNEL A
SHIFT BALANCE
CHANNEL A
R547
R647
NORMAL/INVERT
BALANCE CH. B
R674
SHIFT BALANCE
CHANNEL B
R543
R 514
GAINBALANCE
CHANNEL A
R614
GAIN BALANCE
CHANNEL B
C 507
C 607
C 502
R 521
GAIN X10
CHANNEL A
C 602
R 621
GAIN X10
CHANNEL B
R1041
TRIGGER
SENSITIVITY
D.C. BALANCE
CHANNEL A
R504
D.C. BALANCE
CHANNEL B
R604
TRIGGER
SYMMETRY
R1014
CAL.
R1607

Fig. 3.17. Adjusting elements amplifier board

3.3. INFORMATION FOR ASSISTENCE IN FAULTFINDING

3.3.1. Mains transformer data

The available unloaded voltage tappings and the number of turns per winding are listed in the circuit diagram (Fig. 3.39) in the form of a table.

3.3.2. Voltages and waveforms in the instrument

The d.c. voltage levels at the electrodes of the transistors and the voltage waveforms in the time-base generator are shown at the relevant points on the circuit diagram (Fig. 3.39).

The oscilloscope under test must be set in the following way to measure the voltage wave-forms as shown in Fig. 3.39.

- X-POSITION potentiometer R4 at mid-range
- A-POSITION potentiometer R2 at mid-range
- LEVEL potentiometer R5 at mid-range
- SLOPE switch in position "+"
- TRIGGER source selector switch S16 in position "A"
- A and AUTO push-buttons S1A and S2A depressed
- A AMPL/DIV switch S6 to 1 V/div. and potentiometer R7 to CAL
- TIME/DIV switch S10 to 0.2 ms/div., potentiometer R9 to CAL and X MAGN switch S5 to x1.
- Input signal on A input socket X2: 2.5 kHz sine-wave voltage for 8 div. deflection.

3.3.3. Remark

In case of a defect it is always possible to apply to the world wide PHILIPS Service Organization.
When the instrument is to be sent to a PHILIPS Service Workshop for repair, the following points should be observed:

- Attach a label with your name and address to the instrument.
- Give a complete description of the faults found, or the service required.
- Use the original packing, or, if this is no longer available, carefully pack the instrument in a wooden crate or box.
- Send the instrument to the address obtained after consultation with the local PHILIPS Organization.

3.4. DISMANTLING THE INSTRUMENT

3.4.1. General information

This section provides the dismantling procedures required for the removal of components during repair and routine maintenance operations. All circuit boards removed from the oscilloscope should be adequately protected against damage, and all normal precautions regarding the use of tools must be observed.
During dismantling procedures, a careful note of all leads disconnected must be made so that they may be re-connected to their correct terminals during assembly.

Always ensure that the mains supply is disconnected before removing any instrument cover plates.

Damage may result if the instrument is switched on when a circuit board has been removed, or if a circuit board is removed within one minute of switching off the instrument.

3.4.2. Removing the instrument covers

The instrument is protected by three covers: a front panel protection cover, a wrap-around cover with carrying handle, and a rear panel.
To facilitate removal of the wrap-around cover and the rear panel, first ensure that the front cover is in position.

Then proceed as follows:
- Hinge the carrying handle clear of the front cover; to this end, push both pivot centre buttons (Fig. 3.18).
- Stand the instrument on its protective front cover on a flat surface.
- Slacken the two coin-slot screws located on the rear panel.
- Lift the rear panel and unplug the connector on the power supply board.
- Lift off the wrap-around cover.
- For access to the front-panel, stand the instrument horizontally and snap off the front cover.

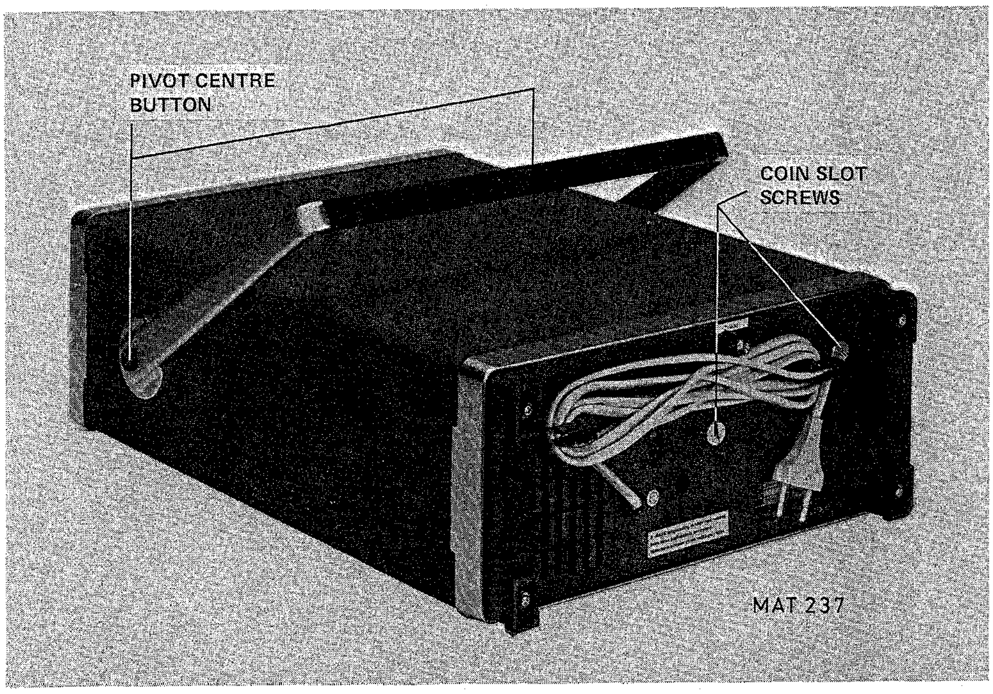


Fig. 3.18. Removing the instrument covers

3.4.3. Removing the carrying handle

- Prise off the centre knobs from each pivot, using a screwdriver (Fig. 3.19) in one of the small slots at the sides of the knobs.
- Remove the cross-slotted screws that are now accessible.
- Bend both arms of the handle slightly outwards and take it off the cabinet.
- Grip and arms of the carrying handle must be ordered separately (see list of mechanical parts). A complete carrying handle can easily be constructed by pressing the arms into the grip.

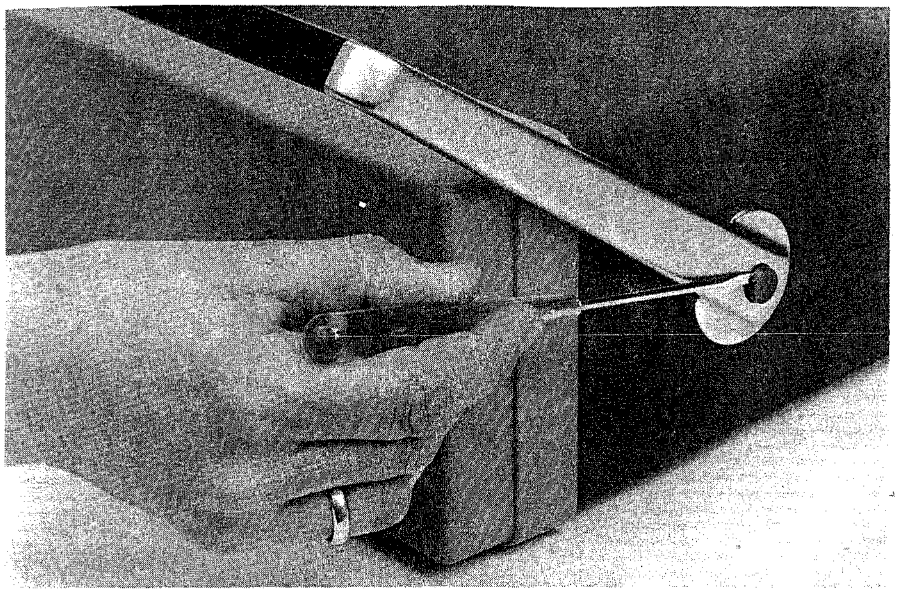


Fig. 3.19. Removing the carrying handle

3.4.4. Removing the bezel and the contrast plate

- Take hold of the bezel's bottom corners and gently pull it from the front panel (Fig. 3.20).
- The contrast filter can be removed by pressing it gently out of the bezel.

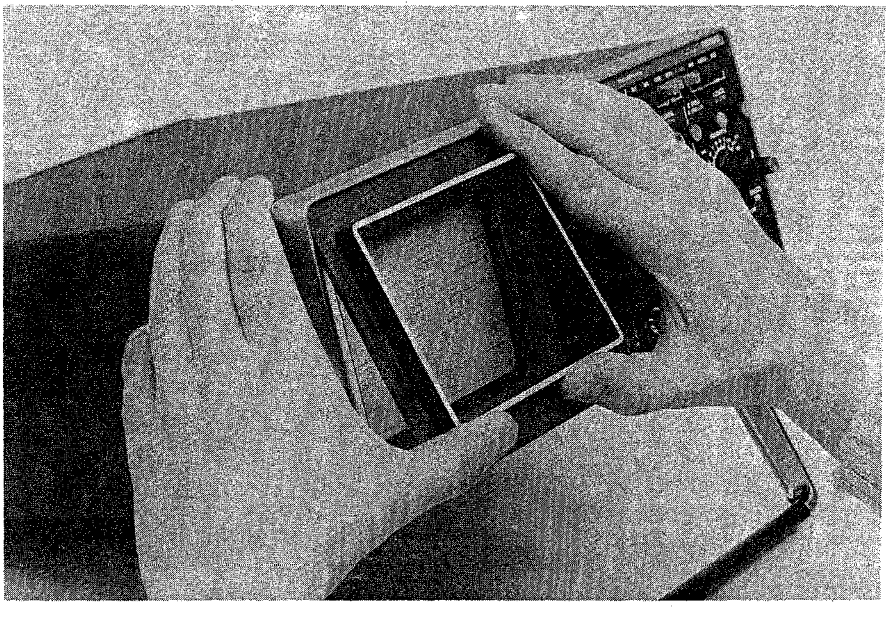


Fig. 3.20. Removing the bezel and the contrast plate

3.4.5. Removing the knobs and the text plate

- The channel B POSITION and the X POSITION knobs can be removed after prising off the knob caps and unscrewing the slotted nuts that are then accessible.
- The remaining small knobs can be pulled off the shafts.
- The AMPL/DIV and TIME/DIV switch knobs can be removed after prising off the knob caps and unscrewing the hexagonal nuts that are then accessible.
- When the knobs have been removed, the text plate can be taken off after removing the hexagonal nuts of the AMPL/DIV and the TIME/DIV switches.

3.4.6. Removing the front assembly

In order to gain access to parts on the AMPL/DIV switches, to replace trimmer capacitors or other components on the attenuator board, it is best to remove the front panel assembly as a whole in accordance with the following procedure.

- Remove the instrument covers in accordance with section 3.4.2.
- Remove the INTENS, FOCUS and ILLUM knobs by pulling them off the shaft.
- Remove the earthing terminal at the front.
- Remove the three screws A (Fig. 3.21).
- Remove the two screws B that hold the attenuator to the frame bar (Fig. 3.22).
- Remove the three screws C (Fig. 3.23).
- Make a note of the positions of the miniature socket connections on the amplifier board.
- Remove all plugs, miniature sockets, coaxial sockets and clamping terminals from the unit and the amplifier board.
- Remove the complete front assembly from the instrument: screening covers can then be removed to gain access to and remove parts.
- When the front panel assembly is reinstalled, make sure not to interchange the connections of the Y position controls. The connections are correct when the trace shifts upwards if the Y position control is rotated clockwise.

3.4.7. Replacing switches

3.4.7.1. General

- To replace the AMPL/DIV switches, first remove the front panel assembly (section 3.4.6.).
- To replace the TIME/DIV switch, first remove knobs and text plate (section 3.4.5.).
- If one of the push-button switches of the trigger source selector (A, B, EXT, LINE) or the input coupling switch (AC/DC 0) must be replaced, it is best to remove the front panel assembly first (section 3.4.6.). The defective switch is then replaced in accordance with the procedure described below.
- To replace one of the push-button switches of the vertical mode switch (A, ALT, CHOP, ADD, B) or the trigger mode switch (AUTO, AC, DC, TV, SLOPE), the amplifier board can be removed if so desired and the defective switch is then replaced as described below.

3.4.7.2. Replacing a switch of a push-button unit

- Straighten the 4 retaining lugs of the relevant switch as shown in Fig. 3.24.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed-wiring board (e.g. with a suction soldering iron)
- Solder the new switch on to the printed-wiring board.
- Bend the four retaining lugs back to their original positions.

N.B. The ALT switch is a dummy switch which can be replaced by a not self-releasing type.

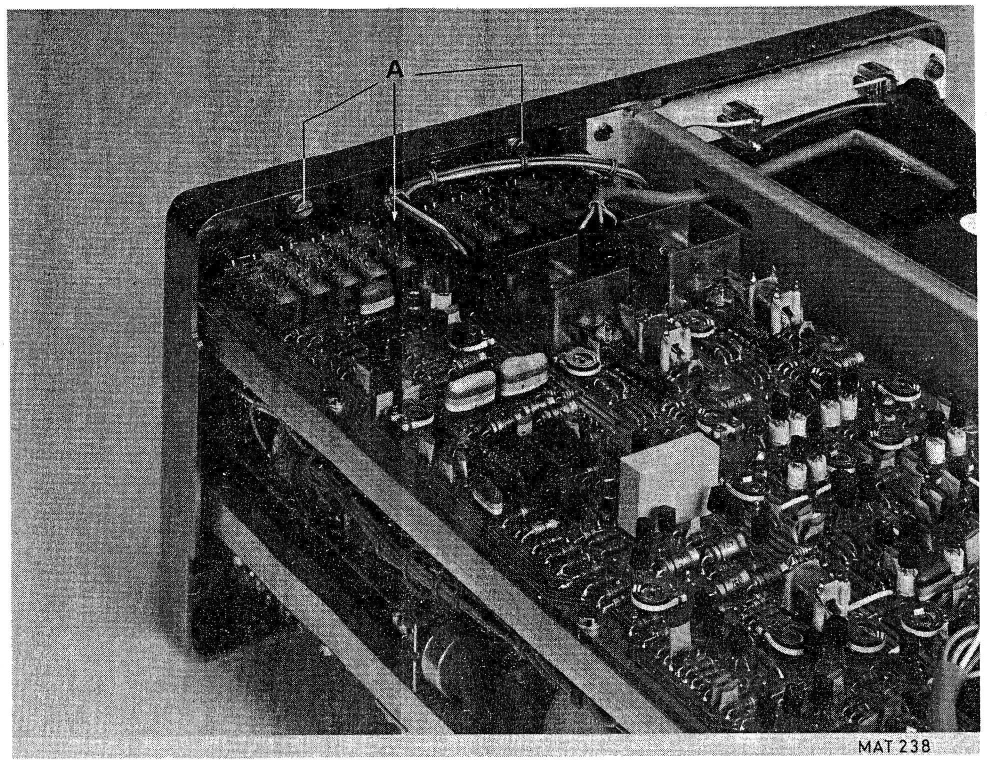


Fig. 3.21. Removing the front assembly (screws A)

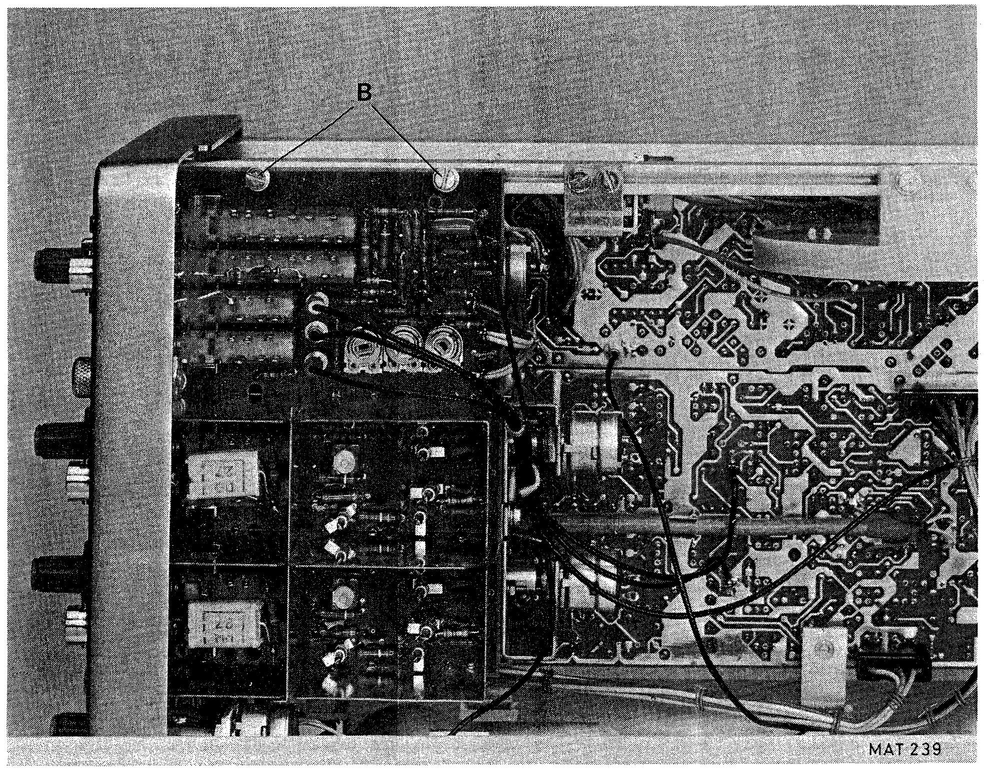


Fig. 3.22. Removing the front assembly (screws B)

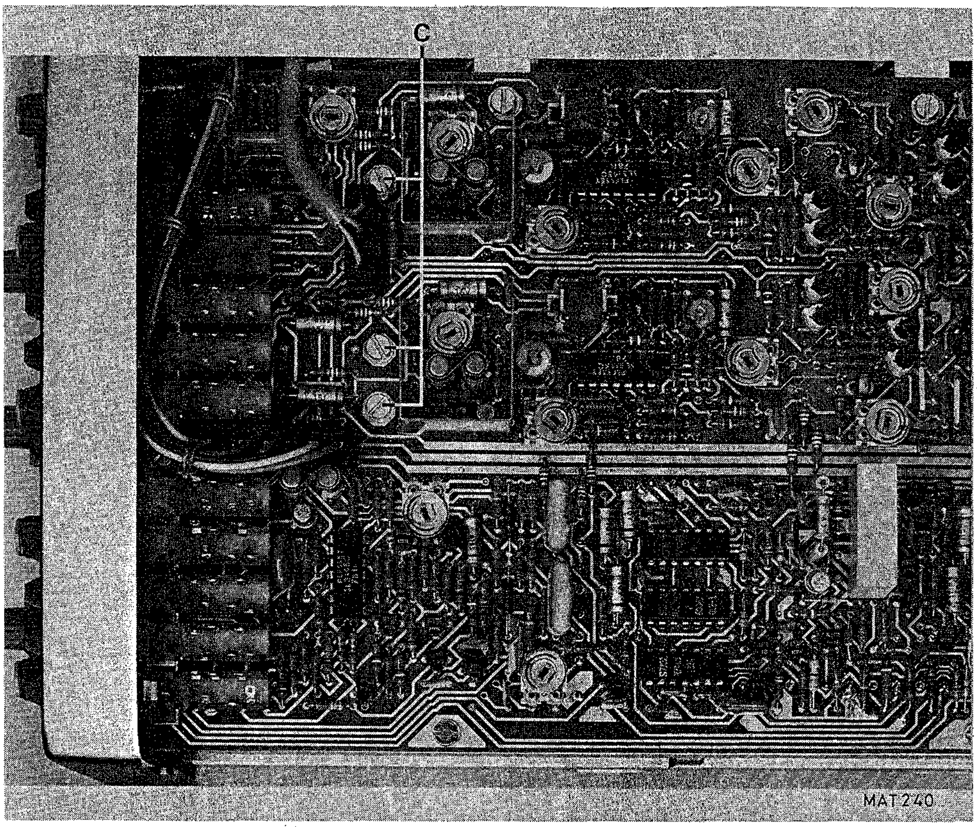


Fig. 3.23. Removing the front assembly (screws C)

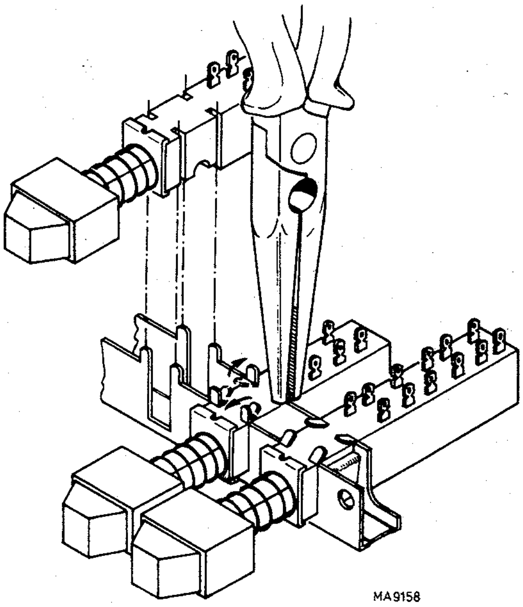


Fig. 3.24. Replacing a push-button switch

3.4.8. Replacing the cathode-ray tube

- Remove the instrument covers and rear frame (section 3.4.2.).
- Remove bezel and contrast plate (section 3.4.4.).
- Unplug the connectors on the c.r.t. neck.
- Ease the base socket off the c.r.t.
- Slacken the brace around the c.r.t. neck.
- Unplug the trace rotation coil connector on the amplifier board and pull cable and plug through the elongated hole in the centre frame.
- Withdraw the c.r.t. through the front panel until the e.h.t. connector at the side of the tube becomes accessible
- Remove the e.h.t. connector.
- Take the c.r.t. out of the instrument via the front panel; mind the wire and plug of the trace rotation coil.
- Install a c.r.t. in reverse order; position the c.r.t. screen flush with the contrast plate. The torque applied to the screw of the brace around the c.r.t. neck must be between 0.4 and 0.6 Nm.

3.4.9. Removing the mains transformer

- Remove wrap-around cover and rear panel (section 3.4.2.).
- Take the lid off the voltage adapter compartment after removing the 4 cross-slotted screws.
- Remove the 4 cross-slotted screws that hold the lid of the transformer compartment.
- Lift the lid with the attached transformer, simultaneously sliding the wire form between transformer and voltage adapter out of the slit in the transformer compartment.
- The transformer and thermal fuse are then accessible for replacement.

3.4.10. Replacing the thermal fuse

- Remove the mains transformer (section 3.4.9.).
- Unsolder fuse terminals 1 and 2 (Fig. 3.25 and 3.26).
- Only the fuse wire of the old fuse is replaced and not the complete fuse; to this end, bend the housing of the fuse slightly outwards, disengage the locking pin and pull out the wire.
- Take the new fuse and remove the fuse wire out of its housing in the same way as described above.
- Push the new fuse wire into the housing of the old one until the locking pin snaps into the hole. The loop in the fuse wire must point to terminal 1.
- Solder the fuse wire to terminals 1 and 2.

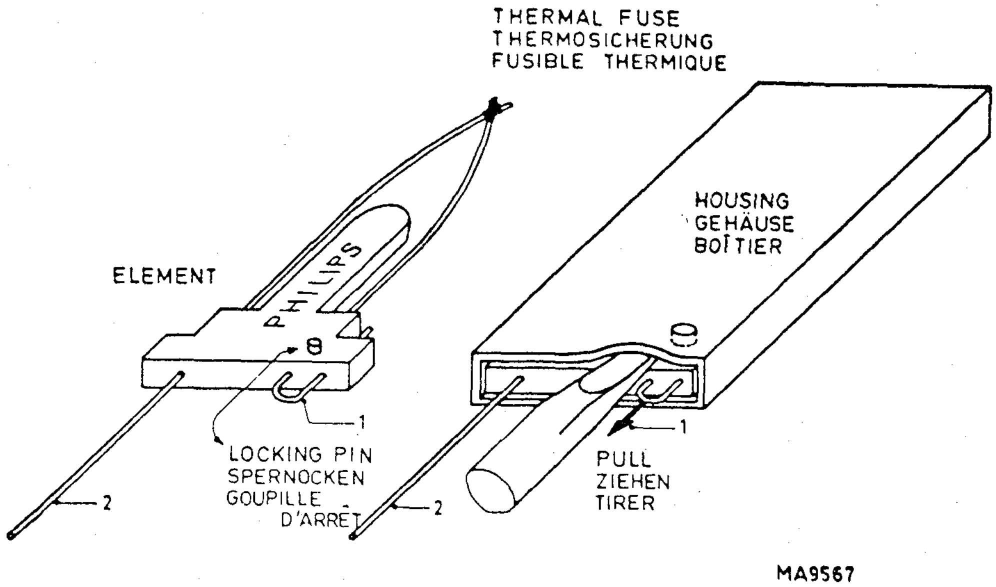


Fig. 3.25. Replacing the thermal fuse

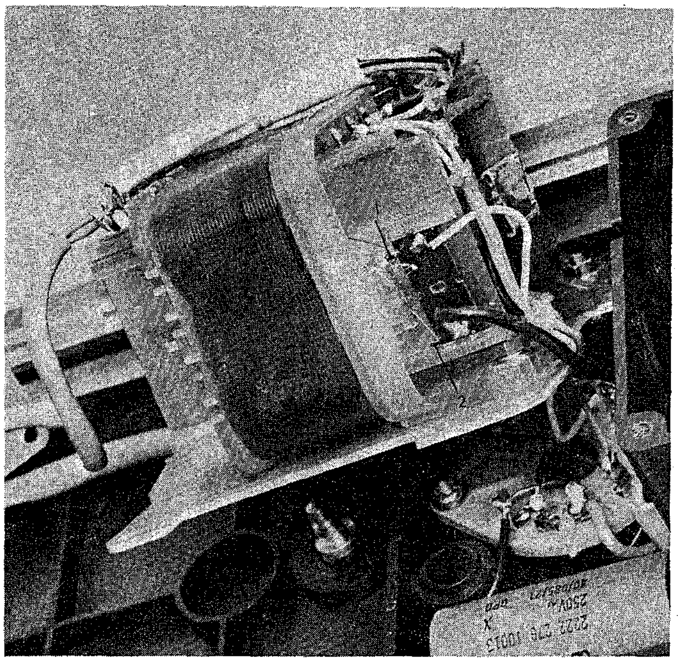


Fig. 3.26. Replacing the thermal fuse

3.4.11. Replacing the delay line unit

- If there is a defect in the delay line, the complete delay line unit must be replaced.
- Replacement is self-evident, but take care not to interchange the connections at the same end of the delay line; interchange of the connections results in a downward movement of the trace when rotating the POSITION control clockwise.
- Before mounting it must be checked, that the new delay line is placed in its housing like shown in Fig. 3.27.

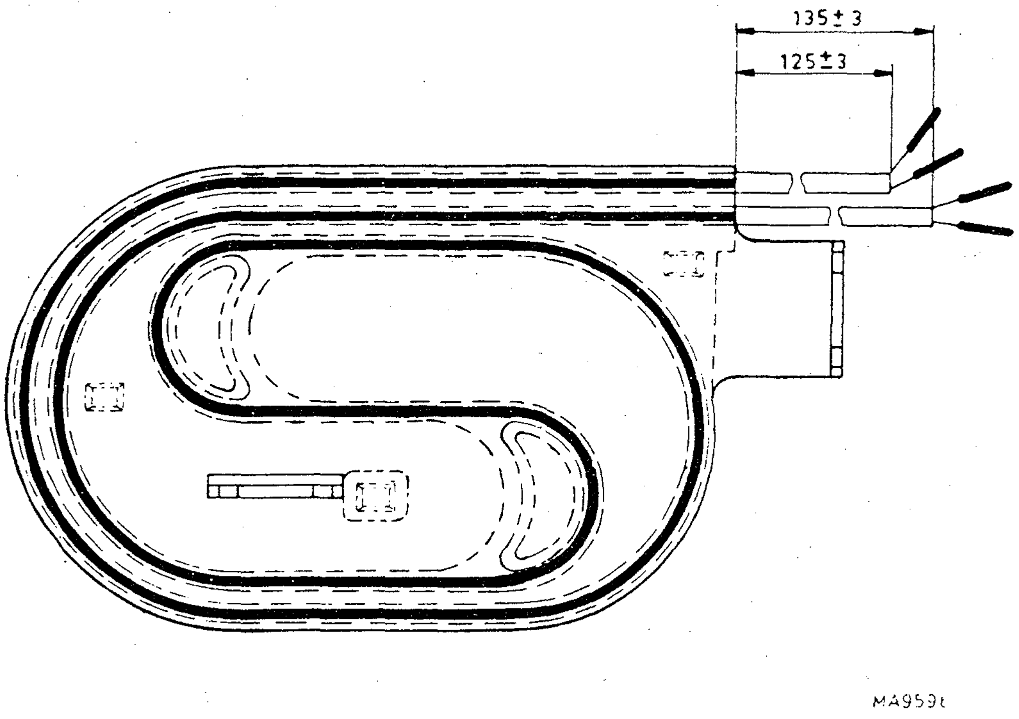


Fig. 3.27. Delay line

3.5. INFORMATION CONCERNING ACCESSORIES

3.5.1. Attenuator probe set

This 10x attenuator probe is designed for oscilloscopes up to 35 MHz, having a BNC input jack and 15 to 40 pF input capacitance, paralleled by 1 MΩ.

The set consists of (Fig. 3.28):

1 Earth cable	not shown
2 Probe holder	item 2
10 Soldering terminals	item 3
2 Marking rings red	item 4
2 Marking rings white	item 5
2 Marking rings blue	not shown
2 Probe tips	item 6
1 Insulating cap	item 7
2 Insulating caps for DIL	item 8
1 Wrap pin adaptor	item 9
1 Spring-loaded test clip	item 10
1 Probe assembly	–

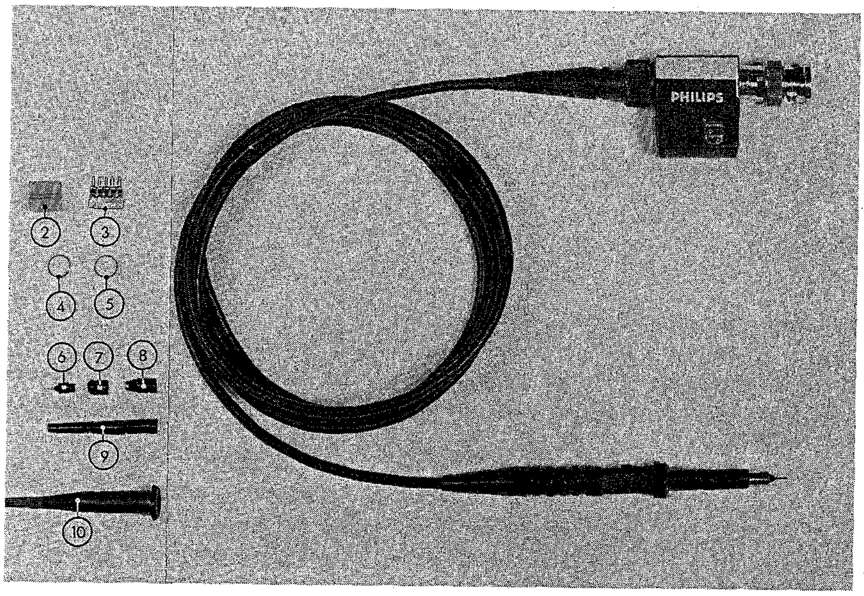


Fig. 3.28. Attenuator probe set

3.5.1.1. Technical data

Attenuation	10x ± 2%	(Oscilloscope input 1 MΩ)
Input resistance d.c. ÷ 100 kHz	10 MΩ ± 2%	(Oscilloscope input 1 MΩ)
Input capacitance d.c. and l.f.	11 pF ± 1 pF	(Oscilloscope input 1 MΩ ± 5% paralled by 15-40 pF)
Maximum allowable input voltage	500 V (d.c. + a.c. peak)	

3.5.1.2. *Adjustment*

The measuring probe has been adjusted and checked by the factory. However, to match the probe to your oscilloscope, the following manipulation is necessary.
Connect the measuring pin to socket CAL of the oscilloscope.
A trimmer can be adjusted through a hole in the compensation box to obtain optimum square-wave response.
See the following examples.

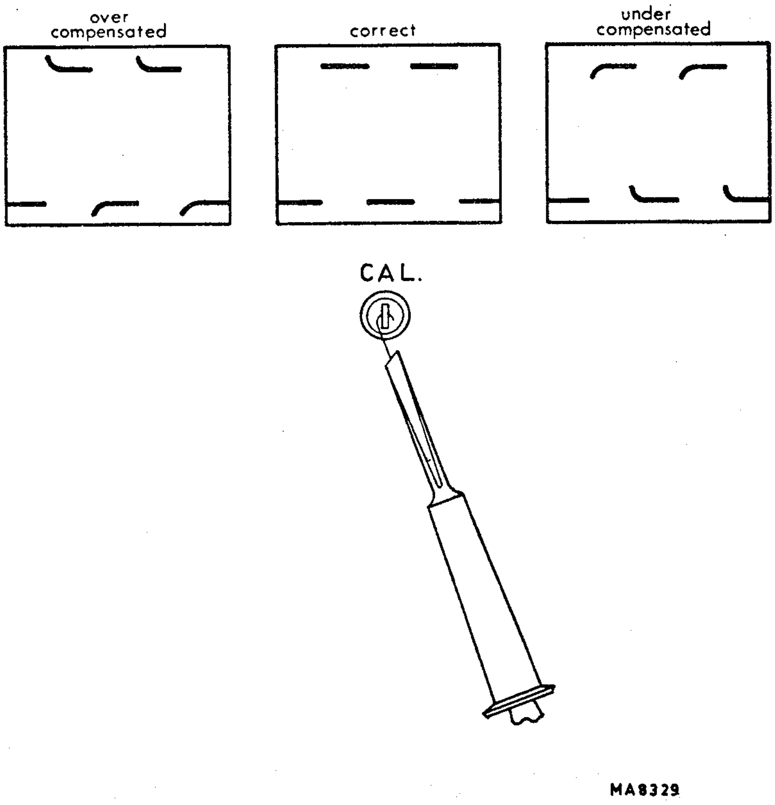


Fig. 3.29. Probe compensation

3.5.1.3. *Parts of attenuator probe set (see Fig. 3.28)*

Item	*Qty.*	*Ordering code*	*Description*
1	1	5322 321 20223	Earth cable
2	1	5322 256 94136	Probe holder
3	10	5322 255 44026	Soldering terminals
4	2	5322 532 64223	Marking ring red
5	2	5322 532 64224	Marking ring white
	2	5322 532 64225	Marking ring blue (not shown)
6	2	5322 268 14017	Probe tip
7	1	5322 462 44319	Insulating cap
8	2	5322 462 44318	Insulating cap for DIL measurements
9	1	5322 264 24018	Wrap pin adaptor
10	1	5322 264 24019	Spring-loaded test clip
11	1	5322 320 14063	Cable assembly

3.5.2. Trimming Tool Kit (Type 800/NTX)

This useful kit contains 3 twin-coloured holders, 2 extension holders and 21 interchangeable trimming pins. The wide variety of pins allows almost every type of trimming function to be carried out in instruments to be calibrated (e.g. measuring instruments, radio and T.V. sets).

Ordering number: 4822 310 50015.
(A spare set containing the 8 most commonly used pins is available under the Ordering number: 4822 310 50016).

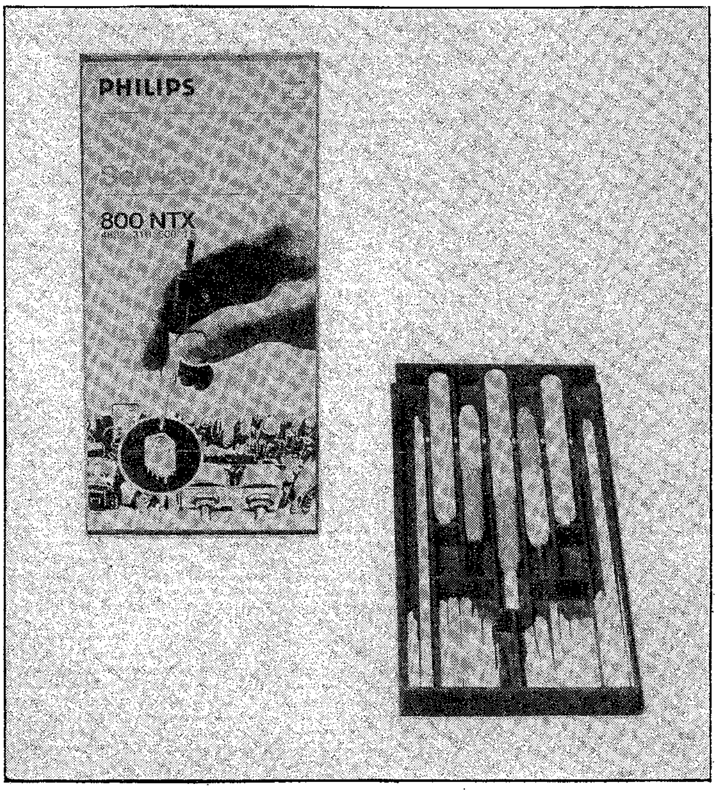


Fig. 3.30. Trimming tool kit

3.6. EXTRA IN- AND OUTPUT CIRCUITS

The PM 3216 is equipped with Z-mod input mounted at the rear panel and with facilities to add two extra output circuits with a minimum of components. The in- and output BNC sockets are mounted in the holes above the c.r.t. socket; only 15-mm-holes must be drilled in the plastic rear cover (Fig. 3.31) on the positions as indicated.

3.6.1. External Z-modulation input

Characteristics

- TTL Compatible
- Current drain at 0 V: −3 mA; at +5 V: +1 mA
- Brightness: light from +2 V to +7 V maximum
  dark from +0.8 V to −1.2 V minimum
- Rise time from light to dark and vice versa: 50 ns
- Delay time from input socket to screen: 85 ns

Used components

– Coax. cable (per metre)	5322 320 10003
– BNC connector	5322 267 10004
– Filler ring for BNC connector	5322 532 24319
– Nut for BNC connector	5322 506 14001
– Solder tag	5322 290 34022

3.6.2. Time-base sweep output

Characteristics

- Output voltage: minimum level −1,8 V
  maximum level +3,8 V ± 0.5 V
- Internal resistance: 1 kohm
- The output is protected against short-circuits

Required components

– Coax. cable (per metre)	5322 320 10003
– BNC connector	5322 267 10004
– Filler ring for BNC connector	5322 532 24319
– Nut for BNC connector	5322 506 14001
– Resistor 1 kohm	5322 116 54549
– Resistor 1.27 kohm	5322 116 50555
– Transistor BC548C	5322 130 44196
– Solder tag	5322 290 34022

Fitting the output

- Fit the BNC connector as described in section 3.6.
- Fit the resistors as indicated in Fig. 3.32.
- Fit the transistor as indicated in Fig. 3.32.
- Connect one end of the coaxial cable to the points indicated in Fig. 3.32 and the other end to the BNC connector.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

3.6.3. Time-base gate output

Characteristics

- Output voltage: high level more than +2.7 V
  low level less than 0.5 V
- TTL output via 50 ohm resistor
- The output is protected against short-circuits

Required components

– Coax. cable (per metre)	5322 320 10003
– BNC connector	5322 267 10004
– Filler ring for BNC connector	5322 532 24319
– Nut for BNC connector	5322 506 14001
– Resistor 51.1 ohm	5322 116 54442
– Solder tag	5322 290 34022

Fitting the output

- Fit the BNC connector as described in section 3.6.
- Fit the resistor as indicated in Fig. 3.32.
- Connect one end of the coaxial cable to the points indicated in Fig. 3.32 and the other end to the BNC connector.
- Make sure that the coaxial cable is also earthed at the BNC connector end.

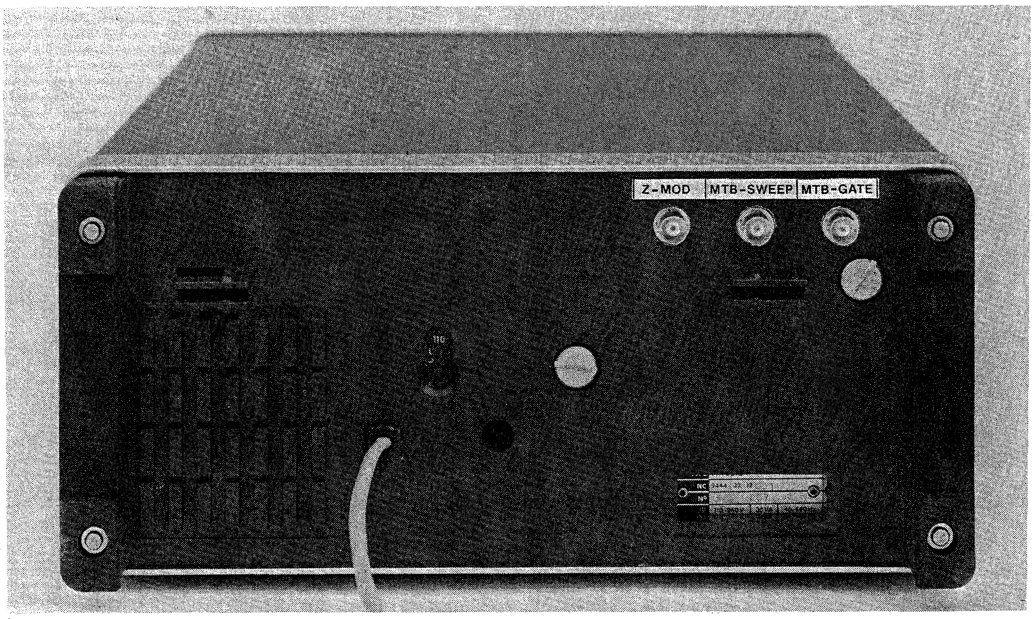


Fig. 3.31. Rear view of the oscilloscope

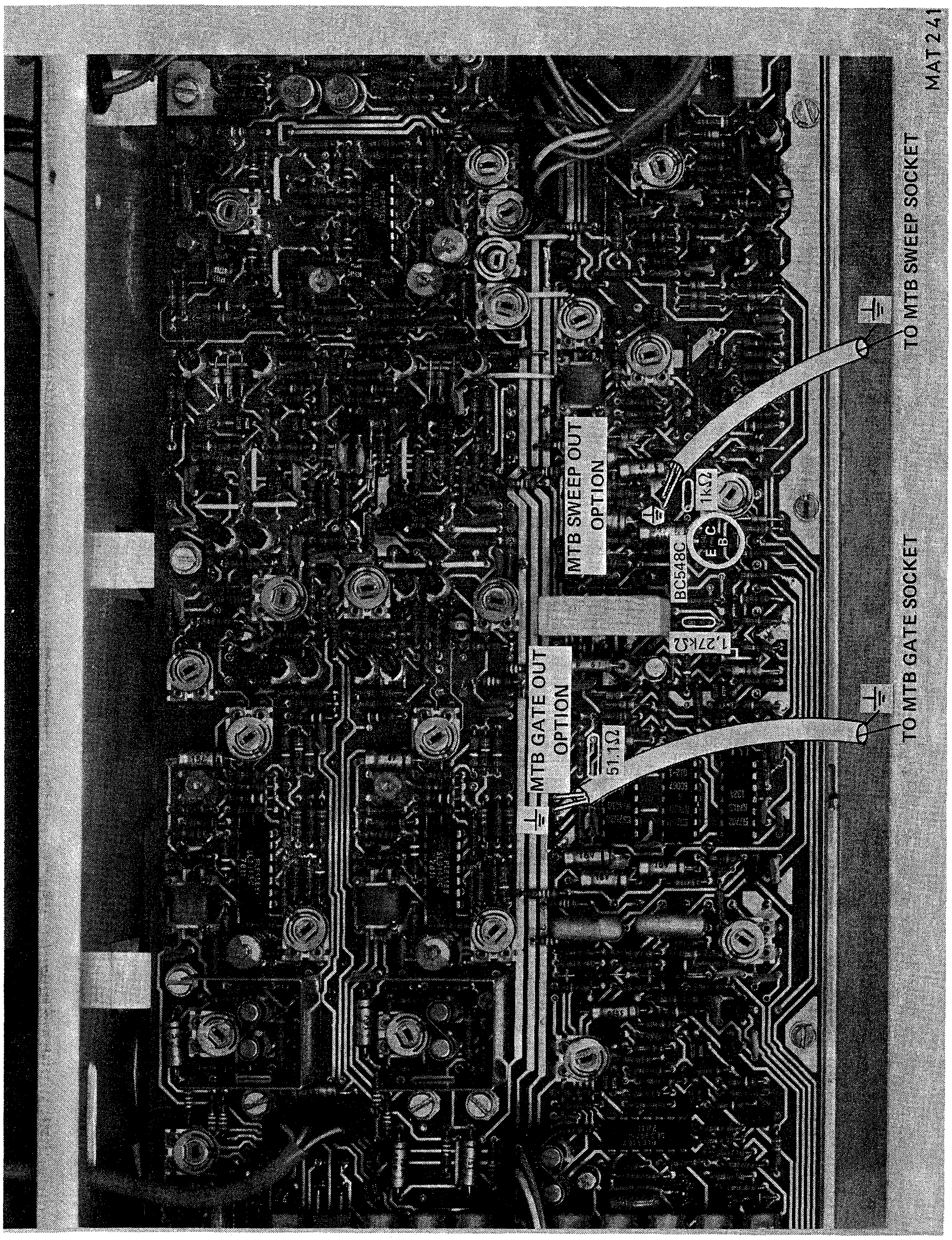

MAT 241
TO MTB SWEEP SOCKET
TO MTB GATE SOCKET
MTB SWEEP OUT OPTION
MTB GATE OUT OPTION
BC548C
E C B
1kΩ
1,27kΩ
51,1Ω

Fig. 3.32. Mounting the component and the cables

3.7. PARTS LISTS AND DIAGRAMS (Subject to alteration without notice)

3.7.1. Mechanical parts

Fig. 3.33.

Item	*Qty.*	*Ordering number*	*Designation*
1	1	5322 447 94366	Cabinet without handle
2	1	5322 464 94002	Cast aluminium front frame
3	1	5322 450 74009	Bezel
4	1	5322 480 34074	Contrast filter blue
5	1	5322 264 24015	Calibration terminal
6	1	5322 325 84013	Grommet for calibration terminal
7	2	5322 414 34091	Knob
8	1	5322 455 84054	Text plate
9	15	5322 414 14011	Knob for push-button switch, grey
10	3	5322 414 25613	Knob for push-button switch, green
11	8	5322 414 34134	Knob
11	8	5322 492 64337	Clamping spring for knob
12	7	5322 414 74015	Knob cover grey
13	3	5322 414 34079	Knob
14	3	5322 414 74029	Knob cover blue
15	3	5322 267 10004	BNC connector
16	1	5322 535 84346	Earthing terminal
17	1	5322 505 14178	Knurled nut for earthing terminal
18	1	5322 506 14005	Hexagonal nut for earthing terminal
19	1	5322 447 94367	Front cover
20	1	5322 466 64162	Grip
21	1	5322 263 24005	BNC-4 mm adapter
22	2	5322 498 54072	Bracket
23	2	5322 520 14267	Bearing bush
24	2	5322 528 34128	Ratchet
25	2	5322 530 84075	Spring
26	2	5322 414 64053	Knob
27	2	4822 502 30054	Screw
28	2	4822 532 10582	Washer
29	1	5322 414 34217	Knob
	1	5322 492 64337	Spring
Fig. 3.34			
29	1	5322 464 94001	Cast aluminium rear frame
30	1	5322 464 94003	Rear panel
31	1	4822 272 10079	Line voltage adapter
32	2	5322 500 14228	Coin slot screw
33	2	4822 530 70126	Circlip
34	1	4822 265 20051	D.C. Power input socket
35	1	5322 325 64083	Line cable cleat
36	1	4822 321 10084	Line cable, European type
		4822 321 10092	Line cable, U.S.A. type
37	2	5322 462 44298	Foot (rear panel)
Not shown			
38	5	5322 276 14102	Self-releasing push-button segment
49	13	5322 276 14117	Mutual-releasing push-button segment
40	1	5322 255 44088	LED holder
41	2	5322 255 24015	Lamp holder
42	4	5322 462 44297	Foot (cabinet)
43	1	4822 266 20014	D.C. Power input plug
44	1	4822 321 20125	D.C. Power input cord set

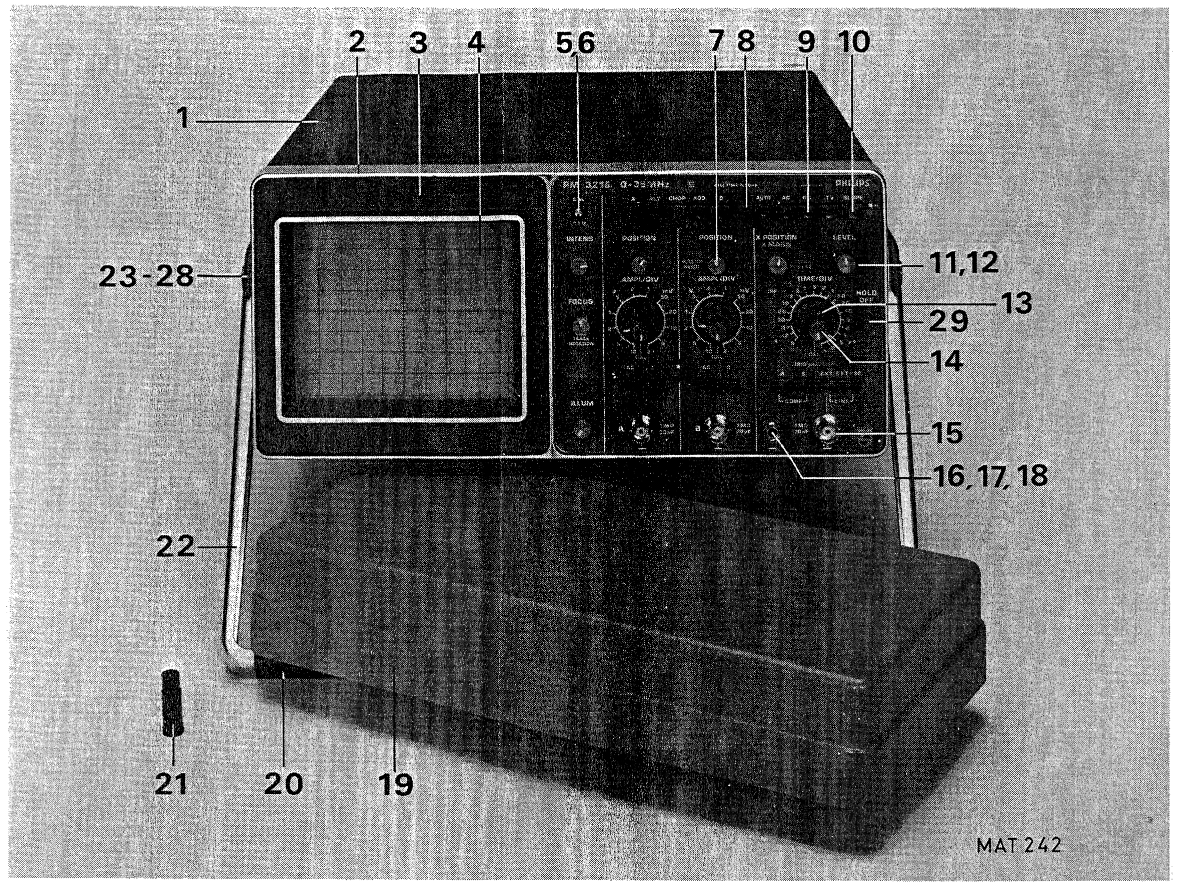


Fig. 3.33. Front view showing item numbers

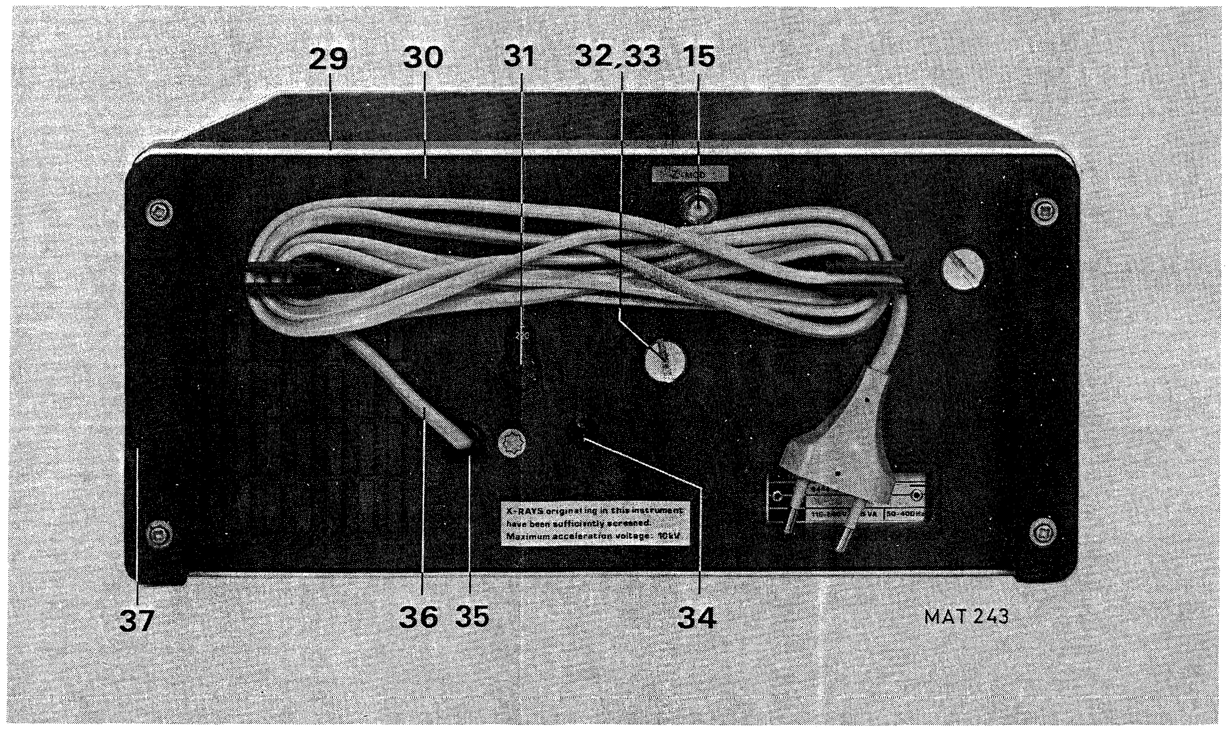


Fig. 3.34. Rear view showing item numbers

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
CAPACITORS					
C 101	5322 121 44189	330 NF		250	POLYESTER FOIL
C 200	4822 121 41161	100 NF	10	250	POLYESTER FOIL
C 201	4822 122 30099	3,3NF	10	100	CERAMIC PLATE
C 202	4822 121 40443	680 NF	10	100	POLYESTER FOIL
C 203	4822 124 70226	4700UF	-10+50	40	ELECTROLYTIC
C 204	4822 121 41161	100 NF	10	250	POLYESTER FOIL
C 206	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 207	4822 121 40443	680 NF	10	100	POLYESTER FOIL
C 208	4822 124 20477	47UF	-10+50	25	ELECTROLYTIC
C 209	4822 124 20697	10UF	-10+50	25	ELECTROLYTIC
C 211	4822 124 20671	68UF	-10+50	6,3	ELECTROLYTIC
C 212	5322 122 54004	470 PF	20	4000	CERAMIC DISK
C 213	5322 122 54004	470 PF	20	4000	CERAMIC DISK
C 214	5322 122 54004	470 PF	20	4000	CERAMIC DISK
C 216	5322 122 54004	470 PF	20	4000	CERAMIC DISK
C 217	5322 122 54004	470 PF	20	4000	CERAMIC DISK
C 218	4822 121 40196	22 NF	10	1600	POLYESTER FOIL
C 219	4822 121 40196	22 NF	10	1600	POLYESTER FOIL
C 221	4822 124 20316	4UF	-10+50	250	ELECTROLYTIC
C 222	4822 124 20488	100UF	-10+50	40	ELECTROLYTIC
C 223	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 224	4822 124 20473	220UF	-10+50	16	ELECTROLYTIC
C 226	4822 124 20671	68UF	-10+50	6,3	ELECTROLYTIC
C 227	4822 124 20457	470UF	-10+50	6,3	ELECTROLYTIC
C 228	4822 124 20468	33UF	-10+50	16	ELECTROLYTIC
C 229	4822 124 20473	220UF	-10+50	16	ELECTROLYTIC
C 231	4822 124 20316	4UF	-10+50	250	ELECTROLYTIC
C 301	4822 121 40012	100 NF	10	400	POLYESTER FOIL
C 305	4822 122 31072	47PF	2	500	CERAMIC PLATE
C 307	5322 125 50051	18 PF		300	TRIMMER
C 308	4822 122 31072	47PF	2	500	CERAMIC PLATE
C 309	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 310	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 311	4822 122 31196	12PF	2	500	CERAMIC PLATE
C 312	4822 122 31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 313	5322 125 54027	5,5 PF		400	TRIMMER
C 314	5322 125 54027	5,5 PF		400	TRIMMER
C 315	4822 122 31184	1,5PF	0,25PF	500	CERAMIC PLATE
C 316	5322 125 54026	3 PF		400	TRIMMER
C 317	5322 125 54026	3 PF		400	TRIMMER
C 318	5322 125 54027	5,5 PF		400	TRIMMER
C 319	5322 125 54026	3 PF			TRIMMER
C 320	4822 122 31188	3,3PF	0,25PF	500	CERAMIC PLATE
C 321	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 322	4822 122 30093	120PF	2	100	CERAMIC PLATE
C 324	4822 122 30093	120PF	2	100	CERAMIC PLATE
C 351	4822 122 31203	39PF	2	500	CERAMIC PLATE
C 353	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 354	4822 122 31036	2,2PF	0,25PF	100	CERAMIC PLATE
C 356	4822 121 40423	150 NF	10	100	POLYESTER FOIL
C 357	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 358	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 359	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 361	4822 122 31198	18PF	2	500	CERAMIC PLATE
C 362	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 401	4822 121 40012	100 NF	10	400	POLYESTER FOIL
C 405	4822 122 31072	47PF	2	500	CERAMIC PLATE
C 407	5322 125 50051	18 PF		300	TRIMMER
C 408	4822 122 31072	47PF	2	500	CERAMIC PLATE
C 409	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 410	4822 122 31197	15PF	2	500	CERAMIC PLATE
C 411	4822 122 31196	12PF	2	500	CERAMIC PLATE
C 412	4822 122 31217	3,9PF	0,25PF	500	CERAMIC PLATE
C 413	5322 125 54027	5,5 PF		400	TRIMMER
C 414	5322 125 54027	5,5 PF		400	TRIMMER
C 415	4822 122 31184	1,5PF	0,25PF	500	CERAMIC PLATE

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 416	5322 125 54026	3 PF		400	TRIMMER
C 417	5322 125 54026	3 PF		400	TRIMMER
C 418	5322 125 54027	5,5 PF		400	TRIMMER
C 419	5322 125 54026	3 PF		400	TRIMMER
C 420	4822 122 31188	3,3PF	0,25PF	500	CERAMIC PLATE
C 421	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 422	4822 122 30093	120PF	2	100	CERAMIC PLATE
C 424	4822 122 30093	120PF	2	100	CERAMIC PLATE
C 501	4822 122 31072	47PF	2	100	CERAMIC PLATE
C 502	4822 125 50045	22 PF		100	TRIMMER
C 503	4822 122 30113	180PF	2	100	CERAMIC PLATE
C 504	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 507	5322 125 50048	3,5 PF		300	TRIMMER
C 509	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 511	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 513	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 517	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 518	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 519	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 521	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 522	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 523	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 524	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 527	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 528	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 529	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 530	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 531	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 532	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 601	4822 122 31072	47PF	2	100	CERAMIC PLATE
C 602	4822 125 50045	22 PF		100	TRIMMER
C 603	4822 122 30113	180PF	2	100	CERAMIC PLATE
C 604	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 607	5322 125 50048	3,5 PF		300	TRIMMER
C 609	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 611	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 613	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 616	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 617	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 618	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 619	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 621	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 622	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 623	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 627	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 629	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 630	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 631	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 632	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 701	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 702	4822 122 31168	270PF	10	100	CERAMIC PLATE
C 703	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 704	4822 122 31174	2,7NF	10	100	CERAMIC PLATE
C 705	4822 122 31125	4,7NF	-20+80	40	CERAMIC PLATE
C 706	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 707	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 801	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 802	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 803	4822 121 41134	10 NF	10	250	POLYESTER FOIL
C 804	4822 122 30113	180PF	2	100	CERAMIC PLATE
C 805	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE
C 806	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 807	4822 122 31074	56PF	2	100	CERAMIC PLATE
C 808	4822 122 31076	68PF	2	100	CERAMIC PLATE
C 809	4822 125 50045	22 PF		100	TRIMMER
C 810	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE
C 811	4822 125 50045	22 PF		100	TRIMMER
C 812	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 813	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 814	4822 122 31054	10PF	2	100	CERAMIC PLATE

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 815	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 816	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 818	5322 125 50048	3,5 PF		300	TRIMMER
C 821	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1001	4822 121 40438	470 NF	10	100	POLYESTER FOIL
C 1002	4822 121 40438	470 NF	10	100	POLYESTER FOIL
C 1003	4822 121 40427	220 NF	10	100	POLYESTER FOIL
C 1004	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1006	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 1007	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1008	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 1011	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1012	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1013	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 1016	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 1017	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1018	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 1019	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 1201	4822 122 31085	150PF	2	100	CERAMIC PLATE
C 1202	4822 121 40423	150 NF	10	100	POLYESTER FOIL
C 1203	4822 122 31168	270PF	10	100	CERAMIC PLATE
C 1204	5322 121 54054	2,4 NF	1	63	POLYSTYRENE FOIL
C 1205	4822 122 31243	82PF	2	100	CERAMIC PLATE
C 1206	5322 122 34041	10NF	-20+50	100	CERAMIC PLATE
C 1207	5322 121 44246	2,2 UF	5	100	POLYESTER FOIL
C 1208	4822 124 20726	4,7UF	-10+50	63	ELECTROLYTIC
C 1209	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 1210	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1211	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1212	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1213	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 1214	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 1216	4822 124 20687	15UF	-10+50	16	ELECTROLYTIC
C 1401	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1402	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1404	4822 121 40427	220 NF	10	100	POLYESTER FOIL
C 1406	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 1407	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 1408	5322 122 34039	0,56PF	0,25PF	100	CERAMIC PLATE
C 1409	5322 125 50048	3,5 PF		300	TRIMMER
C 1411	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1412	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1413	4822 121 40407	220 NF	10	250	POLYESTER FOIL
C 1414	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1416	4822 121 40407	22 NF	10	250	POLYESTER FOIL
C 1417	4822 121 41161	100 NF	10	250	POLYESTER FOIL
C 1418	4822 121 41161	100 NF	10	250	POLYESTER FOIL
C 1419	4822 121 41161	100 NF	10	250	POLYESTER FOIL
C 1421	4822 121 41161	100 NF	10	250	POLYESTER FOIL
C 1501	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1502	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1503	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1504	4822 122 30104	1PF	0,25PF	100	CERAMIC PLATE
C 1506	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1507	4822 121 41134	10 NF	10	250	POLYESTER FOIL
C 1508	4822 122 30099	3,3NF	10	100	CERAMIC PLATE
C 1509	4822 121 40354	1,5 NF	10	1600	POLYESTER FOIL
C 1511	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1512	4822 121 40354	1,5 NF	10	1600	POLYESTER FOIL
C 1513	4822 121 40354	1,5 NF	10	1600	POLYESTER FOIL
C 1601	4822 121 40434	1,5 NF	10	1600	POLYESTER FOIL
C 1602	4822 122 31072	47PF	2	100	CERAMIC PLATE

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
RESISTORS					
R 1	5322 101 24117	10K	20	0.1W	CARBON POTM LIN
R 2	5322 101 24118	1K	20	0.1W	CARBON POTM LIN
R 3	5322 101 64018	1K	20	0.1W	CARBON POTM LIN + SWITCH
R 4	5322 102 44004	2 x 47K	20		CARBON TANDEM POTM + SWITC
R 5	4822 101 20457	100K	20	0.1W	CARBON POTM LIN
R 6	5322 101 24098	2,2M	20	0.1W	CARBON POTM LIN
R 7	5322 101 44024	1K	20	0.1W	CARBON POTM LIN + SWITCH
R 8	5322 101 44024	1K	20	0.1W	CARBON POTM LIN + SWITCH
R 9	5322 101 44023	10K	20		CARBON POTM LIN + SWITCH
R 10	5322 101 20408	100K	20	0,1W	CARBON POTM LIN
R 11	5322 101 44025	22K	20	0.1W	CARBON POTM LIN + SWITCH
R 12	4822 101 20371	47K	20	0.1W	CARBON POTM LIN
R 200	5322 116 54619	10K	1	MR25	METAL FILM
R 201	5322 116 54646	23,7K	1	MR25	METAL FILM
R 202	5322 116 54557	1,21K	1	MR25	METAL FILM
R 203	5322 116 54549	1K	1	MR25	METAL FILM
R 204	5322 101 14051	220	20	0.5W	TRIMMING POTM
R 206	5322 116 50414	2,87K	1	MR25	METAL FILM
R 207	5322 116 50636	2,74K	1	MR25	METAL FILM
R 208	5322 116 50904	30,1	1	MR25	METAL FILM
R 209	5322 116 50904	30,1	1	MR25	METAL FILM
R 210	5322 116 54188	1M	1	MR30	METAL FILM
R 211	5322 111 50345	8,2M	5	1W	CARBON
R 212	5322 116 54619	10K	1	MR25	METAL FILM
R 227	5322 116 50679	237	1	MR25	METAL FILM
R 302	5322 116 54188	1M	1	MR30	METAL FILM
R 303	5322 116 54469	100	1	MR25	METAL FILM
R 304	5322 116 54459	75	1	MR25	METAL FILM
R 306	5322 116 54459	75	1	MR25	METAL FILM
R 307	5322 116 55319	191K	1	MR30	METAL FILM
R 308	5322 116 54263	681K	1	MR30	METAL FILM
R 309	5322 116 55209	845K	1	MR30	METAL FILM
R 311	5322 116 55139	549K	1	MR30	METAL FILM
R 312	5322 116 54727	205K	1	MR25	METAL FILM
R 313	5322 116 55321	732K	1	MR30	METAL FILM
R 314	5322 116 55078	806K	1	MR30	METAL FILM
R 316	4822 110 63212	8,2M	10	CR25	CARBON
R 317	5322 116 54188	1M	1	MR30	METAL FILM
R 318	5322 116 50859	90,9K	0,25	MR24C	METAL FILM
R 319	5322 116 50979	8,25K	0,25	MR24C	METAL FILM
R 351	5322 116 54188	1M	1	MR30	METAL FILM
R 352	5322 116 54549	1K	1	MR25	METAL FILM
R 353	5322 116 55257	953K	1	MR30	METAL FILM
R 354	5322 116 55243	487K	1	MR30	METAL FILM
R 355	5322 116 54708	133K	1	MR25	METAL FILM
R 356	5322 101 14069	22K	20	0.5W	TRIMMING POTM
R 357	5322 116 54643	20,5K	1	MR25	METAL FILM
R 358	5322 101 14069	22K	20	0.5W	TRIMMING POTM
R 359	5322 116 54643	20,5K	1	MR25	METAL FILM
R 360	5322 116 54426	121	1	MR25	METAL FILM
R 361	5322 101 14069	22K	20	0.5W	TRIMMING POTM
R 362	5322 116 54643	20,5K	1	MR25	METAL FILM
R 363	5322 116 54558	8,25K	1	MR25	METAL FILM
R 364	5322 116 54592	4,02K	1	MR25	METAL FILM
R 365	5322 116 54192	5,11	1	MR25	METAL FILM
R 366	5322 116 50581	2,49K	1	MR25	METAL FILM
R 367	5322 116 54565	1,62K	1	MR25	METAL FILM
R 368	5322 116 54192	5,11	1	MR25	METAL FILM
R 369	5322 116 54565	1,62K	1	MR25	METAL FILM
R 370	5322 116 50452	10	1	MR25	METAL FILM
R 371	5322 116 50452	10	1	MR25	METAL FILM
R 372	5322 116 54714	154K	1	MR25	METAL FILM
R 373	5322 116 54123	511K	1	MR30	METAL FILM
R 374	5322 116 50452	10	1	MR25	METAL FILM
R 402	5322 116 54188	1M	1	MR30	METAL FILM
R 403	5322 116 54469	100	1	MR25	METAL FILM
R 404	5322 116 54459	75	1	MR25	METAL FILM
R 406	5322 116 54459	75	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 407	5322 116 55319	191K	1	MR30	METAL FILM
R 408	5322 116 54263	681K	1	MR30	METAL FILM
R 409	5322 116 55209	845K	1	MR30	METAL FILM
R 411	5322 116 55139	549K	1	MR30	METAL FILM
R 412	5322 116 54727	205K	1	MR25	METAL FILM
R 413	5322 116 55321	732K	1	MR30	METAL FILM
R 414	5322 116 55078	806K	1	MR30	METAL FILM
R 416	4822 110 63212	8,2M	10	CR25	CARBON
R 417	5322 116 54188	1M	1	MR30	METAL FILM
R 418	5322 116 50859	90,9K	0,25	MR24C	METAL FILM
R 419	5322 116 50979	8,25K	0,25	MR24C	METAL FILM
R 500	5322 116 54442	51,1	1	MR25	METAL FILM
R 501	5322 116 54442	51,1	1	MR25	METAL FILM
R 502	5322 116 55078	806K	1	MR30	METAL FILM
R 503	5322 116 50443	12,7K	1	MR25	METAL FILM
R 504	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 506	5322 116 50443	12,7K	1	MR25	METAL FILM
R 507	5322 116 50608	6,19K	1	MR25	METAL FILM
R 508	5322 116 54603	6,49K	1	MR25	METAL FILM
R 509	5322 116 54529	619	1	MR25	METAL FILM
R 511	5322 116 55318	511	0,5	MR25	METAL FILM
R 512	5322 116 55318	511	0,5	MR25	METAL FILM
R 513	5322 116 54472	105	1	MR25	METAL FILM
R 514	5322 101 14069	22K	20	0.5W	TRIMMING POTM
R 516	5322 116 50672	51,1K	1	MR25	METAL FILM
R 517	5322 116 50583	5,9K	1	MR25	METAL FILM
R 518	5322 116 54469	100	1	MR25	METAL FILM
R 519	5322 116 50417	162	1	MR25	METAL FILM
R 521	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 522	5322 116 50818	44,2	1	MR25	METAL FILM
R 523	5322 116 50818	44,2	1	MR25	METAL FILM
R 524	5322 116 54469	100	1	MR25	METAL FILM
R 526	5322 116 54469	100	1	MR25	METAL FILM
R 527	5322 116 55425	5,62K	0,5	MR25	METAL FILM
R 528	5322 116 55278	909	0,5	MR25	METAL FILM
R 529	5322 116 54442	51,1	1	MR25	METAL FILM
R 531	5322 116 54442	51,1	1	MR25	METAL FILM
R 532	5322 116 55278	909	0,5	MR25	METAL FILM
R 533	5322 116 55425	5,62K	0,5	MR25	METAL FILM
R 534	5322 116 54541	825	1	MR25	METAL FILM
R 535	5322 116 54541	825	1	MR25	METAL FILM
R 536	5322 116 50904	30,1	1	MR25	METAL FILM
R 537	5322 116 54543	866	1	MR25	METAL FILM
R 538	5322 116 34054	1,5K	5	0.5W	NTC
R 539	5322 116 50904	30,1	1	MR25	METAL FILM
R 540	5322 116 54519	402	1	MR25	METAL FILM
R 541	5322 116 54515	348	1	MR25	METAL FILM
R 542	5322 116 54499	249	1	MR25	METAL FILM
R 543	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 546	5322 116 54549	1K	1	MR25	METAL FILM
R 547	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 548	5322 116 54549	1K	1	MR25	METAL FILM
R 549	5322 116 54469	100	1	MR25	METAL FILM
R 550	5322 116 50452	10	1	MR25	METAL FILM
R 551	5322 116 54469	100	1	MR25	METAL FILM
R 552	5322 116 54426	121	1	MR25	METAL FILM
R 553	5322 116 54426	121	1	MR25	METAL FILM
R 554	5322 116 54545	909	1	MR25	METAL FILM
R 558	5322 116 54637	17,8K	1	MR25	METAL FILM
R 559	5322 116 54595	5,11K	1	MR25	METAL FILM
R 568	5322 116 54637	17,8K	1	MR25	METAL FILM
R 569	5322 116 50583	5,9K	1	MR25	METAL FILM
R 571	5322 116 54492	178	1	MR25	METAL FILM
R 572	5322 116 54492	178	1	MR25	METAL FILM
R 573	5322 116 50675	2,26K	1	MR25	METAL FILM
R 577	5322 116 54469	100	1	MR25	METAL FILM
R 581	5322 116 50568	4,99	1	MR25	METAL FILM
R 582	5322 116 50568	4,99	1	MR25	METAL FILM
R 583	5322 116 50568	4,99	1	MR25	METAL FILM
R 584	5322 116 50568	4,99	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 586	5322 116 50568	4,99	1	MR25	METAL FILM
R 587	5322 116 50568	4,99	1	MR25	METAL FILM
R 600	5322 116 54442	51,1	1	MR25	METAL FILM
R 601	5322 116 54442	51,1	1	MR25	METAL FILM
R 602	5322 116 55078	806K	1	MR30	METAL FILM
R 603	5322 116 50443	12,7K	1	MR25	METAL FILM
R 604	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 606	5322 116 50443	12,7K	1	MR25	METAL FILM
R 607	5322 116 50608	6,19K	1	MR25	METAL FILM
R 608	5322 116 54603	6,49K	1	MR25	METAL FILM
R 609	5322 116 54529	619	1	MR25	METAL FILM
R 611	5322 116 55318	511	0,5	MR25	METAL FILM
R 612	5322 116 55318	511	0,5	MR25	METAL FILM
R 613	5322 116 54472	105	1	MR25	METAL FILM
R 614	5322 101 14069	22K	20	0.5W	TRIMMING POTM
R 616	5322 116 50672	51,1K	1	MR25	METAL FILM
R 617	5322 116 50583	5,9K	1	MR25	METAL FILM
R 618	5322 116 54469	100	1	MR25	METAL FILM
R 619	5322 116 50417	162	1	MR25	METAL FILM
R 621	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 622	5322 116 50818	44,2	1	MR25	METAL FILM
R 623	5322 116 50818	44,2	1	MR25	METAL FILM
R 624	5322 116 54469	100	1	MR25	METAL FILM
R 626	5322 116 54469	100	1	MR25	METAL FILM
R 627	5322 116 55425	5,62K	0,5	MR25	METAL FILM
R 628	5322 116 55278	909	0,5	MR25	METAL FILM
R 629	5322 116 54442	51,1	1	MR25	METAL FILM
R 631	5322 116 54442	51,1	1	MR25	METAL FILM
R 632	5322 116 55278	909	0,5	MR25	METAL FILM
R 633	5322 116 55425	5,62K	0,5	MR25	METAL FILM
R 634	5322 116 54541	825	1	MR25	METAL FILM
R 635	5322 116 54541	825	1	MR25	METAL FILM
R 636	5322 116 50904	30,1	1	MR25	METAL FILM
R 637	5322 116 54543	866	1	MR25	METAL FILM
R 638	5322 116 34054	1,5K	5	0.5W	NTC
R 639	5322 116 50904	30,1	1	MR25	METAL FILM
R 640	5322 116 54519	402	1	MR25	METAL FILM
R 641	5322 116 55418	158	0,5	MR25	METAL FILM
R 646	5322 116 54549	1K	1	MR25	METAL FILM
R 647	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 648	5322 116 54549	1K	1	MR25	METAL FILM
R 649	5322 116 54469	100	1	MR25	METAL FILM
R 650	5322 116 50452	10	1	MR25	METAL FILM
R 651	5322 116 54469	100	1	MR25	METAL FILM
R 652	5322 116 54426	121	1	MR25	METAL FILM
R 653	5322 116 54426	121	1	MR25	METAL FILM
R 654	5322 116 54545	909	1	MR25	METAL FILM
R 658	5322 116 54637	17,8K	1	MR25	METAL FILM
R 659	5322 116 54595	5,11K	1	MR25	METAL FILM
R 661	5322 116 54657	31,6K	1	MR25	METAL FILM
R 662	5322 116 54637	17,8K	1	MR25	METAL FILM
R 663	5322 116 54629	14K	1	MR25	METAL FILM
R 664	5322 116 54558	8,25K	1	MR25	METAL FILM
R 668	5322 116 54637	17,8K	1	MR25	METAL FILM
R 669	5322 116 50583	5,9K	1	MR25	METAL FILM
R 671	5322 116 54492	178	1	MR25	METAL FILM
R 672	5322 116 54492	178	1	MR25	METAL FILM
R 673	5322 116 50675	2,26K	1	MR25	METAL FILM
R 674	5322 101 14048	47K	20	0,5W	TRIMMING POTM
R 676	5322 116 50482	33,2K	1	MR25	METAL FILM
R 677	5322 116 54469	100	1	MR25	METAL FILM
R 682	5322 116 50568	4,99	1	MR25	METAL FILM
R 683	5322 116 50568	4,99	1	MR25	METAL FILM
R 684	5322 116 50568	4,99	1	MR25	METAL FILM
R 701	5322 116 54469	100	1	MR25	METAL FILM
R 702	5322 116 50555	1,27K	1	MR25	METAL FILM
R 703	5322 116 54536	750	1	MR25	METAL FILM
R 704	5322 116 54519	402	1	MR25	METAL FILM
R 705	5322 116 50568	4,99	1	MR25	METAL FILM
R 706	5322 116 50555	1,27K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 707	5322 116 54643	20,5K	1	MR25	METAL FILM
R 708	5322 116 54012	6,81K	1	MR25	METAL FILM
R 709	5322 116 50581	2,49K	1	MR25	METAL FILM
R 710	5322 116 50568	4,99	1	MR25	METAL FILM
R 711	5322 116 50581	2,49K	1	MR25	METAL FILM
R 712	5322 116 54592	4,02K	1	MR25	METAL FILM
R 713	5322 116 54592	4,02K	1	MR25	METAL FILM
R 714	5322 116 54592	4,02K	1	MR25	METAL FILM
R 716	5322 116 54592	4,02K	1	MR25	METAL FILM
R 717	5322 116 54852	100	1	MR30	METAL FILM
R 801	5322 116 54592	4,02K	1	MR25	METAL FILM
R 802	5322 116 54558	8,25K	1	MR25	METAL FILM
R 803	5322 116 54469	100	1	MR25	METAL FILM
R 804	5322 116 54469	100	1	MR25	METAL FILM
R 806	5322 116 54426	121	1	MR25	METAL FILM
R 807	5322 116 54426	121	1	MR25	METAL FILM
R 808	5322 116 50671	2,61K	1	MR25	METAL FILM
R 809	5322 116 54561	1,33K	1	MR25	METAL FILM
R 811	5322 116 50458	7,87K	1	MR25	METAL FILM
R 812	5322 101 14008	2,2K	20	0.5W	TRIMMING POTM
R 813	5322 100 10114	4,7K	20	0.5W	TRIMMING POTM
R 814	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 816	5322 116 50904	30,1	1	MR25	METAL FILM
R 817	4822 100 10075	100	20	0.05W	TRIMMING POTM
R 818	5322 116 50904	30,1	1	MR25	METAL FILM
R 819	5322 116 54068	28,7	1	MR25	METAL FILM
R 821	5322 116 54068	28,7	1	MR25	METAL FILM
R 823	5322 116 54489	169	1	MR25	METAL FILM
R 824	5322 116 50458	7,87K	1	MR25	METAL FILM
R 825	5322 116 50568	4,99	1	MR25	METAL FILM
R 826	5322 116 50675	2,26K	1	MR25	METAL FILM
R 827	5322 116 50729	4,22K	1	MR25	METAL FILM
R 828	5322 116 54469	100	1	MR25	METAL FILM
R 829	5322 116 54469	100	1	MR25	METAL FILM
R 831	5322 116 54464	86,6	1	MR25	METAL FILM
R 832	5322 116 54464	86,6	1	MR25	METAL FILM
R 833	5322 116 54545	909	1	MR25	METAL FILM
R 837	5322 116 54545	909	1	MR25	METAL FILM
R 838	5322 116 54557	1,21K	1	MR25	METAL FILM
R 839	5322 116 54557	1,21K	1	MR25	METAL FILM
R 843	5322 116 54534	681	1	MR25	METAL FILM
R 847	5322 116 54466	90,9	1	MR25	METAL FILM
R 848	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 849	5322 116 54466	90,9	1	MR25	METAL FILM
R 851	5322 116 54466	90,9	1	MR25	METAL FILM
R 852	5322 116 50818	44,2	1	MR25	METAL FILM
R 853	5322 116 50818	44,2	1	MR25	METAL FILM
R 854	5322 116 54466	90,9	1	MR25	METAL FILM
R 856	5322 116 54484	140	1	MR25	METAL FILM
R 857	5322 116 54585	3,48K	1	MR25	METAL FILM
R 858	5322 116 50524	3,01K	1	MR25	METAL FILM
R 859	5322 116 50515	1,78K	1	MR25	METAL FILM
R 861	5322 116 50515	1,78K	1	MR25	METAL FILM
R 862	5322 116 50515	1,78K	1	MR25	METAL FILM
R 863	5322 116 50515	1,78K	1	MR25	METAL FILM
R 1001	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1002	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1003	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1004	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1006	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1007	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1008	5322 116 54743	301K	1	MR25	METAL FILM
R 1009	5322 116 54123	511K	1	MR30	METAL FILM
R 1011	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1012	5322 116 54696	100K	1	MR25	METAL FILM
R 1013	5322 116 50443	12,7K	1	MR25	METAL FILM
R 1014	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 1016	5322 116 50443	12,7K	1	MR25	METAL FILM
R 1017	5322 116 50414	2,87K	1	MR25	METAL FILM
R 1018	5322 116 54009	562	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1019	5322 116 54009	562	1	MR25	METAL FILM
R 1021	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1022	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1023	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1024	5322 116 50904	30,1	1	MR25	METAL FILM
R 1026	5322 116 50904	30,1	1	MR25	METAL FILM
R 1027	5322 116 54529	619	1	MR25	METAL FILM
R 1028	5322 116 54529	619	1	MR25	METAL FILM
R 1029	5322 116 50731	10,5K	1	MR25	METAL FILM
R 1031	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1032	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1033	5322 116 54549	1K	1	MR25	METAL FILM
R 1034	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1036	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1037	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1038	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1039	5322 116 54188	1M	1	MR30	METAL FILM
R 1041	5322 101 14069	22K	20	0.5W	TRIMMING POTM
R 1042	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1043	5322 116 54562	1,4K	1	MR25	METAL FILM
R 1044	5322 116 50728	1,87K	1	MR25	METAL FILM
R 1046	5322 116 54619	10K	1	MR25	METAL FILM
R 1047	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1048	5322 116 54188	1M	1	MR30	METAL FILM
R 1049	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1051	5322 116 54725	196K	1	MR25	METAL FILM
R 1052	5322 116 50583	5,9K	1	MR25	METAL FILM
R 1053	5322 116 50568	4,99	1	MR25	METAL FILM
R 1054	5322 116 50568	4,99	1	MR25	METAL FILM
R 1056	5322 116 50568	4,99	1	MR25	METAL FILM
R 1201	5322 116 54696	100K	1	MR25	METAL FILM
R 1202	5322 116 50442	48,7K	1	MR25	METAL FILM
R 1203	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1204	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1207	5322 116 50452	10	1	MR25	METAL FILM
R 1208	4822 110 63201	3,3M	10	CR25	CARBON
R 1209	5322 116 54619	10K	1	MR25	METAL FILM
R 1211	5322 116 50581	2,49K	1	MR25	METAL FILM
R 1212	5322 116 54619	10K	1	MR25	METAL FILM
R 1213	5322 116 54534	681	1	MR25	METAL FILM
R 1214	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1216	5322 116 54552	1,05K	1	MR25	METAL FILM
R 1217	5322 116 50458	7,87K	1	MR25	METAL FILM
R 1218	5322 116 55421	32,4	0,5	MR25	METAL FILM
R 1219	5322 116 50904	30,1	1	MR25	METAL FILM
R 1220	5322 116 50863	9,09	1	MR25	METAL FILM
R 1221	5322 116 54576	2,37K	1	MR25	METAL FILM
R 1222	5322 116 54617	9,53K	1	MR25	METAL FILM
R 1223	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1224	5322 116 50904	30,1	1	MR25	METAL FILM
R 1226	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1227	5322 116 54608	7,5K	1	MR25	METAL FILM
R 1228	5322 116 50458	7,87K	1	MR25	METAL FILM
R 1229	5322 116 54692	86,6K	1	MR25	METAL FILM
R 1230	5322 116 54674	53,6K	1	MR25	METAL FILM
R 1231	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1232	4822 100 10051	22K	20	0.05W	TRIMMING POTM
R 1233	5322 116 54515	348	1	MR25	METAL FILM
R 1234	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1236	5322 116 50451	21,5K	1	MR25	METAL FILM
R 1237	5322 116 50568	4,99	1	MR25	METAL FILM
R 1238	5322 116 50568	4,99	1	MR25	METAL FILM
R 1239	5322 116 50568	4,99	1	MR25	METAL FILM
R 1276	5322 116 55424	412K	0,5	MR25	METAL FILM
R 1277	5322 116 55387	205K	0,5	MR25	METAL FILM
R 1278	5322 116 55423	41,2K	0,5	MR25	METAL FILM
R 1279	5322 116 55428	8,06K	0,5	MR25	METAL FILM
R 1281	5322 116 55288	2K	0,5	MR25	METAL FILM
R 1282	5322 116 55422	365	0,5	MR25	METAL FILM
R 1283	5322 116 55424	412K	0,5	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1284	5322 116 55374	82,5K	0,5	MR25	METAL FILM
R 1286	5322 116 55419	20,5K	0,5	MR25	METAL FILM
R 1287	5322 116 54283	4,02K	0,1	MR24E	METAL FILM
R 1288	5322 116 55427	768	0,5	MR25	METAL FILM
R 1289	5322 116 55426	6,19K	0,5	MR25	METAL FILM
R 1290	5322 116 55431	931K	0,5	MR30	METAL FILM
R 1291	5322 116 54734	249K	1	MR25	METAL FILM
R 1401	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1402	5322 116 54442	51,1	1	MR25	METAL FILM
R 1403	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1404	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1406	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1407	5322 116 54534	681	1	MR25	METAL FILM
R 1408	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1409	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1411	5322 116 55277	9,09K	1	MR25	METAL FILM
R 1412	5322 116 54576	2,37K	1	MR25	METAL FILM
R 1414	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1416	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1417	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 1418	5322 116 54506	287	1	MR25	METAL FILM
R 1419	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 1421	5322 116 54613	8,66K	1	MR25	METAL FILM
R 1422	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1423	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1424	5322 116 50726	36,5K	1	MR25	METAL FILM
R 1425	5322 116 54469	100	1	MR25	METAL FILM
R 1426	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1427	5322 116 54714	154K	1	MR25	METAL FILM
R 1428	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1429	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1431	5322 116 54549	1K	1	MR25	METAL FILM
R 1432	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1433	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1434	5322 116 54714	154K	1	MR25	METAL FILM
R 1436	5322 116 54554	1,1K	1	MR25	METAL FILM
R 1437	5322 116 50904	30,1	1	MR25	METAL FILM
R 1438	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1439	5322 116 50904	30,1	1	MR25	METAL FILM
R 1440	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1441	5322 116 54554	1,1K	1	MR25	METAL FILM
R 1442	5322 116 55276	13,3K	1	MR25	METAL FILM
R 1443	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1444	5322 116 54762	365K	1	MR30	METAL FILM
R 1445	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1446	5322 116 54762	365K	1	MR30	METAL FILM
R 1447	5322 116 54469	100	1	MR25	METAL FILM
R 1448	5322 116 54469	100	1	MR25	METAL FILM
R 1450	5322 116 50514	64,9K	1	MR25	METAL FILM
R 1501	5322 116 54012	6,81K	1	MR25	METAL FILM
R 1502	5322 116 54525	511	1	MR25	METAL FILM
R 1503	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1506	5322 116 54716	162K	1	MR25	METAL FILM
R 1507	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1508	5322 116 54696	100K	1	MR25	METAL FILM
R 1509	5322 116 54623	11K	1	MR25	METAL FILM
R 1511	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1512	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1513	5322 116 54651	26,1K	1	MR25	METAL FILM
R 1514	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1516	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1517	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1518	5322 116 54525	511	1	MR25	METAL FILM
R 1519	5322 116 50536	464	1	MR25	METAL FILM
R 1521	5322 116 54729	226K	1	MR25	METAL FILM
R 1522	5322 116 34049	680	5	0.5W	NTC
R 1523	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1524	5322 116 54469	100	1	MR25	METAL FILM
R 1525	5322 116 54835	511	1	MR30	METAL FILM
R 1526	4822 116 51175	64,9K	1	MR30	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1527	5322 116 54637	17,8K	1	MR25	METAL FILM
R 1528	5322 116 50482	33,2K	1	MR25	METAL FILM
R 1529	5322 116 50509	4,87K	1	MR25	METAL FILM
R 1531	5322 116 54624	11,5K	1	MR25	METAL FILM
R 1532	5322 116 54188	1M	1	MR30	METAL FILM
R 1533	5322 116 54469	100	1	MR25	METAL FILM
R 1534	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1535	5322 116 54207	1K	1	MR30	METAL FILM
R 1536	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1537	5322 116 54188	1M	1	MR30	METAL FILM
R 1538	4822 110 42189	1,2M	5	VR37	CARBON
R 1539	4822 110 42196	2,2M	5	VR37	CARBON
R 1541	4822 110 42207	5,6M	5	VR37	CARBON
R 1542	5322 116 50533	78,7K	1	MR25	METAL FILM
R 1543	4822 100 10072	100K	20	0.05W	TRIMMING POTM
R 1544	5322 116 54704	121K	1	MR25	METAL FILM
R 1546	5322 116 50593	16,2K	1	MR25	METAL FILM
R 1547	5322 116 54651	26,1K	1	MR25	METAL FILM
R 1548	5322 116 54725	196K	1	MR25	METAL FILM
R 1549	4822 100 10103	1M	20	0.05W	TRIMMING POTM
R 1551	5322 116 54761	383K	1	MR30	METAL FILM
R 1552	5322 116 50568	4,99	1	MR25	METAL FILM
R 1553	5322 116 50568	4,99	1	MR25	METAL FILM
R 1554	5322 116 50568	4,99	1	MR25	METAL FILM
R 1601	5322 116 54508	301	1	MR25	METAL FILM
R 1602	5322 116 50572	12,1K	1	MR25	METAL FILM
R 1603	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1604	5322 116 54619	10K	1	MR25	METAL FILM
R 1606	5322 116 54534	681	1	MR25	METAL FILM
R 1607	5322 101 14069	22K	20	0.5W	TRIMMING POTM
R 1608	5322 116 50483	38,3K	1	MR25	METAL FILM
R 1609	5322 116 54547	953	1	MR25	METAL FILM
R 1611	5322 116 54619	10K	1	MR25	METAL FILM
R 1612	5322 116 54534	681	1	MR25	METAL FILM
R 1613	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1614	5322 116 54585	3,48K	1	MR25	METAL FILM
R 1616	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1617	5322 116 54508	301	1	MR25	METAL FILM
R 1618	5322 116 54651	26,1K	1	MR25	METAL FILM
R 1619	5322 116 50572	12,1K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION
SEMI CONDUCTORS		
V 1	5322 131 24029	D14-125GH/08
V 201	4822 130 50312	BY225-200
V 206	5322 130 34304	BYX49-300
V 207	4822 130 44235	BD237
V 208	4822 130 30613	BAW62
V 209	4822 130 34173	BZX79-C5V6
V 211	4822 130 30765	BZX75-C3V6
V 212	4822 130 30765	BZX75-C3V6
V 213	4822 130 30613	BAW62
V 214	4822 130 44196	BC548C
V 216	4822 130 44197	BC558B
V 217	4822 130 44235	BD237
V 218	4822 130 44235	BD237
V 219	4822 130 30613	BAW62
V 221	4822 130 30613	BAW62
V 222	4822 130 30613	BAW62
V 223	4822 130 30613	BAW62
V 224	4822 130 30613	BAW62
V 226	5322 130 34594	BY409-A
V 227	5322 130 34594	BY409-A
V 228	5322 130 34594	BY409-A
V 229	5322 130 34594	BY409-A
V 231	5322 130 34594	BY409-A
V 232	5322 130 34594	BY409-A
V 233	5322 130 34671	BZX61-C110 PH
V 234	4822 130 30839	BY206
V 236	4822 130 30839	BY206
V 237	4822 130 30613	BAW62
V 238	5322 130 34605	BAX12
V 239	5322 130 34605	BAX12
V 241	5322 130 34605	BAX12
V 242	5322 130 34605	BAX12
V 243	5322 130 34605	BAX12
V 244	5322 130 34605	BAX12
V 246	4822 130 30613	BAW62
V 247	4822 130 30839	BY206
V 351	5322 130 44237	BF450
V 352	5322 130 44237	BF450
V 353	4822 130 44196	BC548C
V 354	4822 130 30613	BAW62
V 501	5322 130 34037	BAV45
V 504	5322 130 40709	BFS21A
V 508	5322 130 44237	BF450
V 509	5322 130 44237	BF450
V 511	5322 130 44237	BF450
V 512	5322 130 44237	BF450
V 513	4822 130 44197	BC558B
V 514	4822 130 44197	BC558B
V 518	4822 130 44196	BC548C
V 519	4822 130 44196	BC548C
V 521	4822 130 30613	BAW62
V 522	4822 130 30613	BAW62
V 523	4822 130 30613	BAW62
V 524	5322 130 44396	BF324
V 526	5322 130 44396	BF324
V 601	5322 130 34037	BAV45
V 604	5322 130 40709	BFS21A
V 608	5322 130 44237	BF450
V 609	5322 130 44237	BF450
V 611	5322 130 44237	BF450
V 612	5322 130 44237	BF450
V 613	4822 130 44197	BC558B
V 614	4822 130 44197	BC558B
V 616	4822 130 44197	BC558B
V 617	4822 130 44197	BC558B
V 618	4822 130 44196	BC548C
V 619	4822 130 44196	BC548C
V 621	4822 130 30613	BAW62

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION	
V 622	4822 130 30613	BAW62	
V 623	4822 130 30613	BAW62	
V 624	5322 130 44396	BF324	
V 626	5322 130 44396	BF324	
V 701	4822 130 30613	BAW62	
V 702	4822 130 30613	BAW62	
V 703	4822 130 44196	BC548C	
V 704	4822 130 44196	BC548C	
V 801	4822 130 44197	BC558B	
V 802	4822 130 44196	BC548C	
V 803	4822 130 44196	BC548C	
V 804	4822 130 44154	BF199	
V 806	4822 130 44154	BF199	
V 807	4822 130 44154	BF199	
V 808	4822 130 44154	BF199	
V 809	4822 130 44196	BC548C	
V 1001	4822 130 30191	OA95	PH
V 1002	4822 130 30191	OA95	PH
V 1003	5322 130 34037	BAV45	
V 1004	4822 130 44196	BC548C	
V 1006	5322 130 44643	ON561	
V 1008	4822 130 44197	BC558B	
V 1009	4822 130 44196	BC548C	
V 1011	4822 130 44196	BC548C	
V 1012	4822 130 44196	BC548C	
V 1013	4822 130 44196	BC548C	
V 1014	5322 130 44237	BF450	
V 1016	4822 130 30613	BAW62	
V 1017	4822 130 44197	BC558B	
V 1201	4822 130 44196	BC548C	
V 1202	4822 130 30613	BAW62	
V 1203	4822 130 44197	BC558B	
V 1204	4822 130 44196	BC548C	
V 1206	4822 130 44197	BC558B	
V 1207	4822 130 30613	BAW62	
V 1208	4822 130 30613	BAW62	
V 1209	4822 130 30613	BAW62	
V 1211	4822 130 30613	BAW62	
V 1212	4822 130 44197	BC558B	
V 1213	5322 130 40417	BSX20	
V 1214	4822 130 44196	BC548C	
V 1216	4822 130 44196	BC548C	
V 1217	4822 130 44196	BC548C	
V 1218	4822 130 30613	BAW62	
V 1219	4822 130 44196	BC548C	
V 1221	4822 130 44196	BC548C	
V 1222	4822 130 30613	BAW62	
V 1223	4822 130 44196	BC548C	
V 1401	4822 130 44196	BC548C	
V 1402	4822 130 44196	BC548C	
V 1403	4822 130 30613	BAW62	
V 1404	4822 130 44197	BC558B	
V 1406	4822 130 44154	BF199	
V 1407	4822 130 44154	BF199	
V 1408	4822 130 30613	BAW62	
V 1409	4822 130 30613	BAW62	
V 1411	4822 130 30613	BAW62	
V 1412	4822 130 34233	BZX79-C5V1	
V 1413	5322 130 44603	BFT45	
V 1414	4822 130 44108	BF338	
V 1416	5322 130 40417	BSX20	
V 1417	4822 130 30613	BAW62	
V 1419	5322 130 44237	BF450	
V 1421	5322 130 44603	BFT45	
V 1422	4822 130 44108	BF338	
V 1423	4822 130 34233	BZX79-C5V1	
V 1424	4822 130 34368	BZX79-C36	
V 1426	4822 130 34368	BZX79-C36	
V 1427	4822 130 34368	BZX79-C36	
V 1428	5322 130 34442	BZX79-C75	

ITEM	ORDERING NUMBER	TYPE/DESCRIPTION	
V 1501	4822 130 30613	BAW62	
V 1502	4822 130 30613	BAW62	
V 1503	4822 130 30613	BAW62	
V 1504	4822 130 30191	OA95	PH
V 1506	4822 130 44196	BC548C	
V 1508	4822 130 30613	BAW62	
V 1511	4822 130 30613	BAW62	
V 1512	4822 130 44197	BC558B	
V 1513	4822 130 44196	BC548C	
V 1514	4822 130 44196	BC548C	
V 1516	4822 130 44196	BC548C	
V 1517	5322 130 44247	BSS68	
V 1518	4822 130 30842	BAV21	
V 1519	4822 130 30842	BAV21	
V 1521	4822 130 44196	BC548C	
V 1522	4822 130 44197	BC558B	
V 1601	4822 130 44196	BC548C	
V 1602	4822 130 44196	BC548C	
V 1603	4822 130 44196	BC548C	
V 1604	4822 130 30613	BAW62	

Item	Ordering number	Type/description
Integrated circuits		
D501	5322 130 34764	SL3145C
D601	5322 130 34764	SL3145C
D801	5322 130 34764	SL3145C
D1001	5322 130 34764	SL3145C
D1201	5322 209 85201	N74LS132A
D1202	5322 209 84167	N74S00A
D1203	5322 209 84954	N74S10A
Miscellaneous		
B1	5322 130 34595	LED CQY24A-I
E1	5322 134 44177	LAMP 28 V 80 mA
E2	5322 134 44177	LAMP 28 V 80 mA
F201	4822 253 30023	Fuse 1,4 A
K501	5322 280 24103	REED RELAIS ASSY
K601	5322 280 24103	REED RELAIS ASSY
K1401	5322 280 24103	REED RELAIS ASSY
L201	5322 281 64154	COIL
L202	5322 281 64154	COIL
L203	5322 281 64154	COIL
L801	5322 156 14074	COIL
L802	5322 156 14074	COIL
L1501	5322 150 14015	ROTARY COIL
T101	5322 146 24166	MAINS TRANSFORMER
	4822 252 20007	THERMAL FUSE
T201	5322 158 34074	BASE TRANSFORMER
T202	5322 146 24163	TRANSFORMER
	5322 216 54142	POWER SUPPLY BOARD
	5322 216 54143	ATTENUATOR BOARD
	5322 218 64056	HIGH VOLTAGE UNIT
	5322 320 44029	DELAY LINE UNIT
S6 S8	5322 105 34034	ATTENUATOR SWITCH
S10	5322 105 34035	TIME BASE SWITCH
	4822 266 30071	3-POLE PLUG
	4822 265 30121	3-POLE SOCKET
	4822 266 30072	4-POLE PLUG
	4822 265 30119	4-POLE SOCKET
	4822 266 30073	6-POLE PLUG
	4822 265 30117	6-POLE SOCKET
	4822 266 40057	7-POLE PLUG
	4822 265 40119	7-POLE SOCKET

COMPONENT LOCATION LIST

Item	*Grid Loc.*
C101	Rear panel
C200	Power supply
C201	Power supply
C202	Power supply
C203	Power supply
C204	Power supply
C206	Power supply
C207	Power supply
C208	Power supply
C209	Power supply
C211	Power supply
C212	High tension unit
C213	
C214	
C216	
C217	
C218	Power supply
C219	Power supply
C221	Power supply
C222	Power supply
C223	Power supply
C224	Power supply
C226	Power supply
C227	Power supply
C228	Power supply
C229	Power supply
C231	Power supply
C301	Att. unit
C305	Att. unit
C307	Att. unit
C308	Att. unit
C309	Att. unit
C310	Att. unit
C311	Att. unit
C312	Att. unit
C313	Att. unit
C314	Att. unit
C315	Att. unit
C316	Att. unit
C317	Att. unit
C318	Att. unit
C319	Att. unit
C320	Att. unit
C321	Att. unit
C322	Att. unit
C324	Att. unit
C351	Att. unit
C352	Att. unit
C353	Att. unit
C354	Att. unit
C356	Att. unit
C357	Att. unit
C358	Att. unit
C401	Att. unit
C405	Att. unit
C407	Att. unit

Item	*Grid Loc.*
C408	Att. unit
C409	Att. unit
C410	Att. unit
C411	Att. unit
C412	Att. unit
C413	Att. unit
C414	Att. unit
C415	Att. unit
C416	Att. unit
C417	Att. unit
C418	Att. unit
C419	Att. unit
C420	Att. unit
C421	Att. unit
C422	Att. unit
C424	Att. unit
C501	C-2
C502	C-2
C503	C-2
C504	C-2
C507	C-2/D-2
C508	D-2
C509	D-2
C511	D-2
C513	E-2
C517	E-2
C518	E-2
C519	E-2
C521	D-2
C522	E-2
C523	C-2
C524	B-3
C527	B-2/C-2
C528	D-3
C529	B-2
C530	C-2
C531	C-2
C532	D-2
C601	C-3
C602	C-3
C603	C-3
C604	C-3
C607	C-3/D-3
C608	D-3
C609	D-2
C611	D-3
C612	D-3
C613	D-3
C614	D-3
C616	E-3
C617	E-3
C618	E-3
C619	E-3
C621	E-3
C622	E-2/E-3
C623	C-2
C627	B-2/C-2
C628	B-3/C-3

Item	*Grid Loc.*
C629	B-3
C630	C-2/C-3
C631	D-3
C632	D-3
C701	D-2
C702	E-2
C703	E-2
C704	E-2
C705	E-2
C706	D-2
C707	E-2
C801	E-3
C802	E-3
C804	F-3
C805	F-2
C806	F-3
C807	E-3
C808	F-3
C809	F-3
C810	F-2
C811	F-3
C812	F-3
C813	F-3
C814	F-2
C815	F-3
C816	F-2
C818	F-2
C821	F-2
C1001	C-3/C-4
C1002	C-4
C1003	B-4
C1004	B-3
C1006	C-3/C-4
C1007	C-4
C1008	C-4
C1011	C-4
C1012	C-4
C1013	B-4
C1016	C-3/C-4
C1017	C-4
C1018	C-3/C-4
C1019	C-4
C1201	D-3
C1202	D-4
C1203	D-3
C1204	D-3/D-4
C1205	D-4
C1206	C-4
C1207	D-3/D-4
C1208	E-3/E-4
C1209	D-3/D-4
C1210	C-4
C1211	C-4
C1212	C-3
C1213	E-4
C1214	E-4
C1216	E-3/E-4

Item	*Grid Loc.*
C1401	E-4
C1402	E-4
C1403	E-4
C1404	F-3
C1406	G-3
C1407	F-3/G-3
C1408	F-3
C1409	F-3/G-3
C1411	F-2/G-2
C1412	F-2/G-2
C1413	F-2/G-2
C1414	G-3
C1416	G-2
C1417	G-2
C1418	G-2
C1419	F-3
C1421	F-2
C1501	E-4
C1502	F-4
C1503	F-4
C1504	F-4
C1506	F-4
C1507	F-4
C1508	F-4
C1509	F-4/G-4
C1511	F-4
C1512	F-4/G-4
C1513	On Tube
C1601	B-2
C1602	A-2
R1	Front panel
R2	
R3	
R4	
R5	
R6	
R7	
R8	
R9	
R10	
R11	
R200	Power supply
R201	Power supply
R202	Power supply
R203	Power supply
R204	Power supply
R206	Power supply
R207	Power supply
R208	Power supply
R209	Power supply
R210	Power supply
R211	High t. u.
R212	Power supply
R227	B-3
R302	Att. unit
R303	On switch S6

Item	*Grid Loc.*
R304	On switch S6
R306	
R307	Att. unit
R308	Att. unit
R309	Att. unit
R311	Att. unit
R312	Att. unit
R313	On switch S6
R314	
R316	Att. unit
R317	Att. unit
R318	Att. unit
R319	Att. unit
R354	Att. unit
R356	Att. unit
R357	Att. unit
R358	Att. unit
R359	Att. unit
R361	Att. unit
R362	Att. unit
R363	Att. unit
R364	Att. unit
R366	Att. unit
R367	Att. unit
R369	Att. unit
R371	Att. unit
R372	Att. unit
R373	Att. unit
R402	Att. unit
R403	On switch S8
R404	
R406	
R407	Att. unit
R408	Att. unit
R409	Att. unit
R411	Att. unit
R412	Att. unit
R413	On switch S8
R414	
R416	Att. unit
R417	Att. unit
R418	Att. unit
R419	Att. unit
R500	C-2
R501	B-2/C-2
R502	B-2/C-2
R503	B-2
R504	B-2/C-2
R506	C-2
R507	D-2
R508	D-2
R509	D-2
R511	C-2
R512	C-2
R513	C-2
R514	D-2

Item	*Grid Loc.*
R1414	E-4
R1416	E-4
R1417	E-4
R1418	E-4
R1419	E-3
R1421	E-4
R1422	E-4
R1423	E-4
R1424	G-3
R1425	F-3
R1426	F-3
R1427	F-2
R1428	F-3
R1429	F-3
R1431	F-3
R1432	G-3
R1433	G-3
R1434	G-2
R1436	F-2
R1437	F-3
R1438	F-3/G-3
R1439	G-3
R1440	On R4
R1441	G-2
R1442	F-3
R1443	G-3
R1444	G-2
R1445	On R4
R1446	G-2
R1447	G-3
R1448	F-3
R1450	On R4
R1501	E-3
R1502	F-3
R1503	E-4
R1506	F-4
R1507	F-4
R1508	F-4
R1509	F-4
R1511	F-4
R1512	F-4
R1513	F-4
R1514	F-4
R1516	F-4
R1517	F-4
R1518	F-4
R1519	F-4
R1521	F-4
R1522	F-4
R1523	F-4
R1524	F-4
R1525	F-4
R1526	F-4
R1527	F-4
R1528	F-4
R1529	F-4

Item	*Grid Loc.*
R1531	F-4
R1532	G-4
R1533	F-4
R1534	F-4
R1535	On tube
R1536	On tube
R1537	G-4
R1538	Power supply
R1539	Power supply
R1541	Power supply
R1542	Power supply
R1543	Power supply
R1544	Power supply
R1546	Power supply
R1547	Power supply
R1548	Power supply
R1549	Power supply
R1551	Power supply
R1552	F-3/F-4
R1553	F-3
R1554	F-3/F-4
R1601	B-2
R1602	B-2
R1603	B-2
R1604	B-2
R1606	B-2
R1607	B-2
R1608	B-2
R1609	B-2
R1611	B-2
R1612	B-2
R1613	B-2
R1614	B-2
R1616	B-2
R1617	B-2
R1618	A-2
R1619	A-2
V1	Tube
V201	Power supply
V202	Power supply
V203	Power supply
V204	Power supply
V206	Power supply
V207	Power supply
V208	Power supply
V209	Power supply
V211	Power supply
V212	Power supply
V213	Power supply
V214	Power supply
V216	Power supply
V217	Power supply
V218	Power supply
V219	Power supply
V221	Power supply
V222	Power supply

Item	*Grid Loc.*
V223	Power supply
V224	Power supply
V226	High tension unit
V227	
V228	
V229	
V231	
V232	Power supply
V233	Power supply
V234	Power supply
V236	Power supply
V237	Power supply
V238	Power supply
V239	Power supply
V241	Power supply
V242	Power supply
V243	Power supply
V244	Power supply
V246	Power supply
V247	Power supply
V351	Att. unit
V352	Att. unit
V353	Att. unit
V354	Att. unit
V501	C-2
V504	B-2/C-2
V508	D-2/E-2
V509	D-2/E-2
V511	D-2
V512	D-2
V513	E-2
V514	E-2
V518	E-2
V519	E-2
V521	E-2
V522	E-2
V523	E-2
V524	E-2
V526	E-2
V601	C-3
V604	B-3/C-3
V608	D-3
V609	D-3
V611	D-2/D-3
V612	D-3
V613	D-3/E-3
V614	E-3
V616	E-3
V617	E-3
V618	E-3
V619	E-3
V621	E-3

Item	*Grid Loc.*
V622	E-3
V623	E-3
V624	E-3
V626	E-3
V701	E-2
V702	E-2/E-3
V703	E-2
V704	E-2
V801	E-2
V802	F-3
V803	F-2
V804	F-2
V806	F-2
V807	F-2
V808	F-2
V809	E-2
V1001	C-3/C-4
V1002	C-4
V1003	B-3/B-4
V1004	B-4
V1006	B-3/C-3
V1008	B-4/C-4
V1009	B-4
V1011	B-4
V1012	B-4/C-4
V1013	C-4
V1014	C-4
V1016	C-4
V1017	B-4/C-4
V1201	D-3
V1202	D-4
V1203	D-4
V1204	D-4
V1206	D-4
V1207	D-4
V1208	D-4
V1209	D-4
V1211	D-4
V1212	D-4
V1213	D-4
V1214	D-4/E-4
V1216	D-3
V1217	D-3/E-3
V1218	E-4
V1219	D-4
V1221	D-4
V1222	D-3/D-4
V1223	E-3
V1401	E-4
V1402	E-4
V1403	E-4
V1404	E-4
V1406	E-4
V1407	E-4
V1408	E-4
V1409	E-4

Item	*Grid Loc.*
V1411	E-4
V1412	F-2
V1413	F-2
V1414	F-2
V1416	F-3/G-3
V1417	F-3
V1419	G-3
V1421	G-3
V1422	G-2
V1423	G-2
V1424	G-2
V1426	G-2
V1427	G-2
V1428	G-2
V1501	D-4
V1502	E-4/F-4
V1503	E-4/F-4
V1504	F-4/F-3
V1506	F-3
V1508	E-4
V1511	F-4
V1512	F-4
V1513	F-4
V1514	F-4
V1516	F-4
V1517	F-4
V1518	F-4
V1519	F-4/G-4
V1521	B-3
V1522	B-3
V1601	B-2
V1602	B-2
V1603	B-2
V1604	B-2
D501	C-2
D601	C-3
D801	F-2/F-3
D802	Delay line
D1001	B-4
D1201	C-4/D-4
D1202	C-4/D-4
D1203	C-4/D-4
B1	LED
F201	Power supply
K501	C-2
K601	C-2/C-3
K1401	E-3
L201	Power supply
L202	Power supply
L203	Power supply
L801	F-2
L802	F-2
L1501	Trace rot. coil
T101	Rear panel
T201	Power supply
T202	Power supply

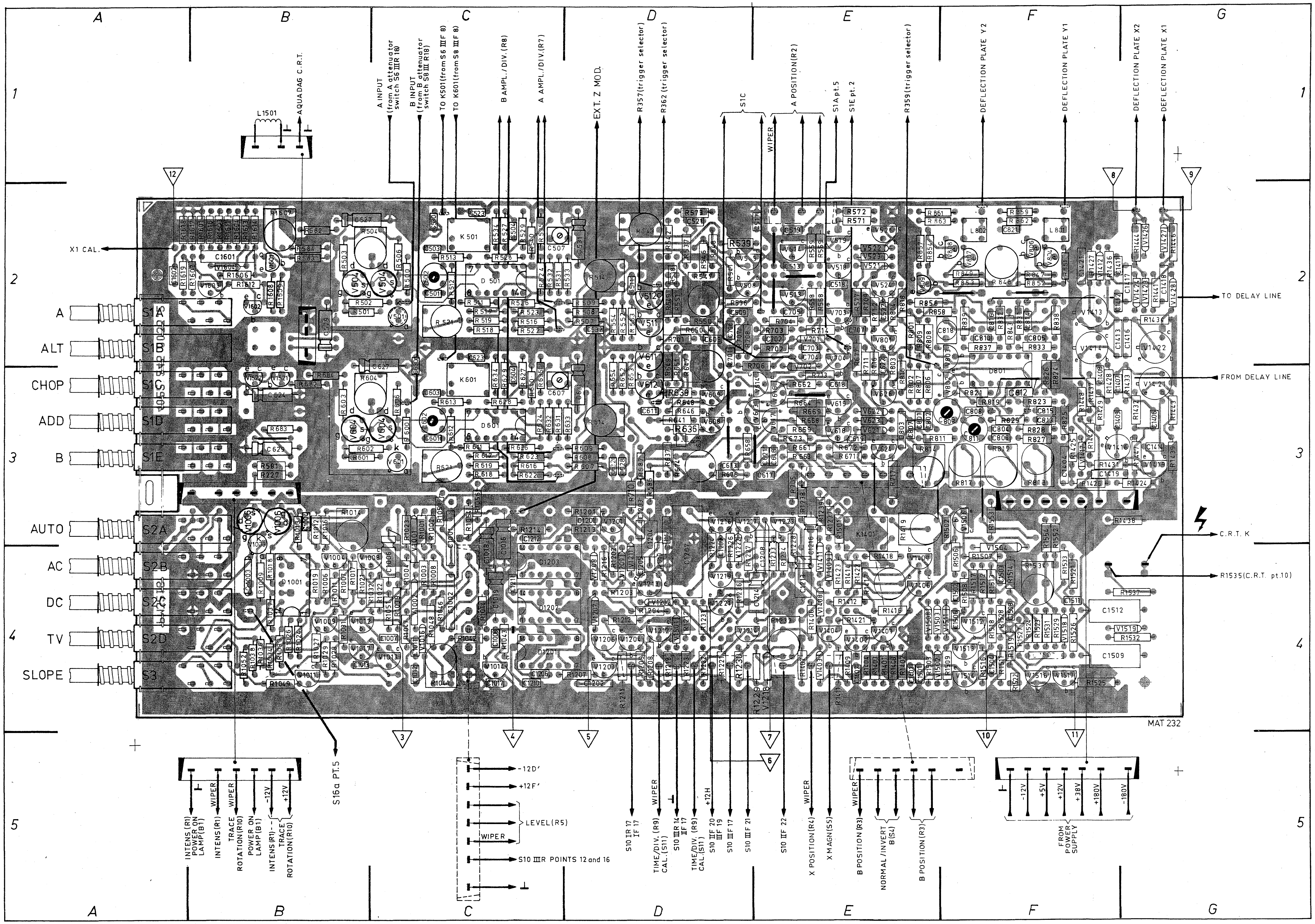

A
B
C
D
E
F
G
1
2
3
4
5
L1501
AQUADAG C.R.T.
A INPUT (from A attenuator switch S6 IIIR 18)
B INPUT (from B attenuator switch S8 III R18)
TO K501 (from S6 III F 8)
TO K601 (from S8 III F 8)
B AMPL./DIV. (R8)
A AMPL./DIV. (R7)
EXT. Z MOD.
R357 (trigger selector)
R362 (trigger selector)
S1C
WIPER
A POSITION (R2)
S1A pt.5
S1E pt.2
R359 (trigger selector)
DEFLECTION PLATE Y2
DEFLECTION PLATE Y1
DEFLECTION PLATE X2
DEFLECTION PLATE X1
X1 CAL.
TO DELAY LINE
FROM DELAY LINE
C.R.T. K
R1535 (C.R.T. pt.10)
A
ALT
CHOP
ADD
B
AUTO
AC
DC
TV
SLOPE
S1A
S1B
S1C
S1D
S1E
S2A
S2B
S2C
S2D
S3
MAT 232
S16a PT.5
INTENS (R1) POWER ON LAMP (B1)
INTENS (R1)
WIPER
WIPER
TRACE ROTATION (R10)
POWER ON LAMP (B1)
-12V
INTENS (R1)
+12V
TRACE ROTATION (R10)
-12D'
+12F'
LEVEL (R5)
WIPER
S10 IIIR POINTS 12 and 16
S10 IR 17 IF 17
WIPER
TIME/DIV. (R9) CAL. (S11)
S10 IIIR 14 IIF 17
TIME/DIV. (R9) CAL. (S11)
+12H
S10 IIF 20 IIIF 19
S10 IIIF 17
S10 IIF 21
S10 IIF 22
WIPER
X POSITION (R4)
X MAGN (S5)
WIPER
B POSITION (R3)
NORMAL/INVERT B (S4)
B POSITION (R3)
-12V
+5V
+12V
+38V
+180V
-180V
FROM POWER SUPPLY
3
4
5
6
7
8
9
10
11
12

Fig. 3.35. Vertical amplifier unit with rear side tracks

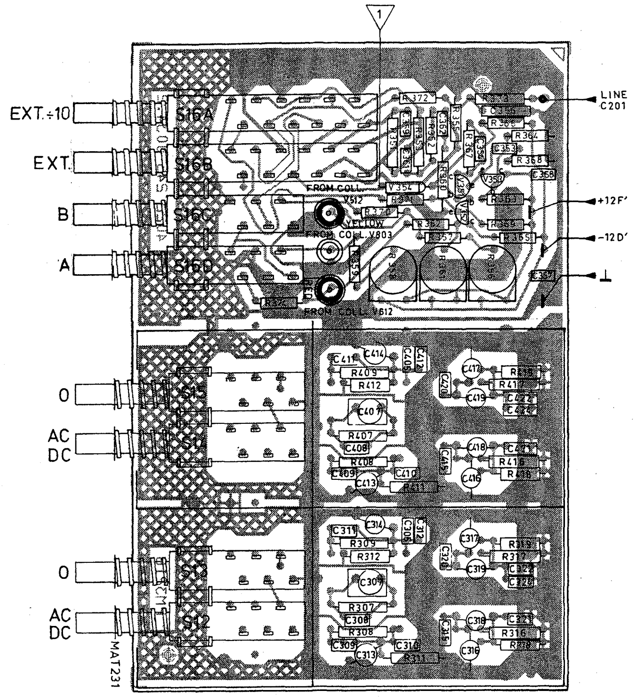

1
EXT.÷10
EXT.
B
A
S16A
S16B
S16C
S16D
FROM COLL. V512
YELLOW
FROM COLL. V803
FROM COLL. V612
LINE
C201
+12F'
-12D'
⊥
0
AC
DC
0
AC
DC
MAT231

Fig. 3.36. Vertical attenuator unit

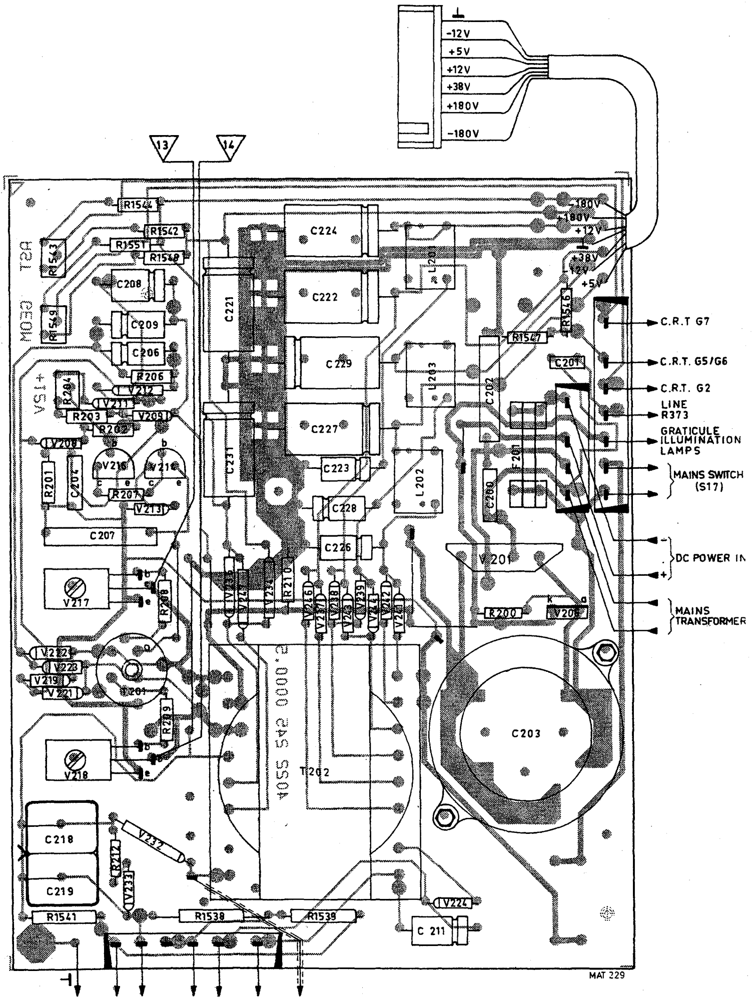
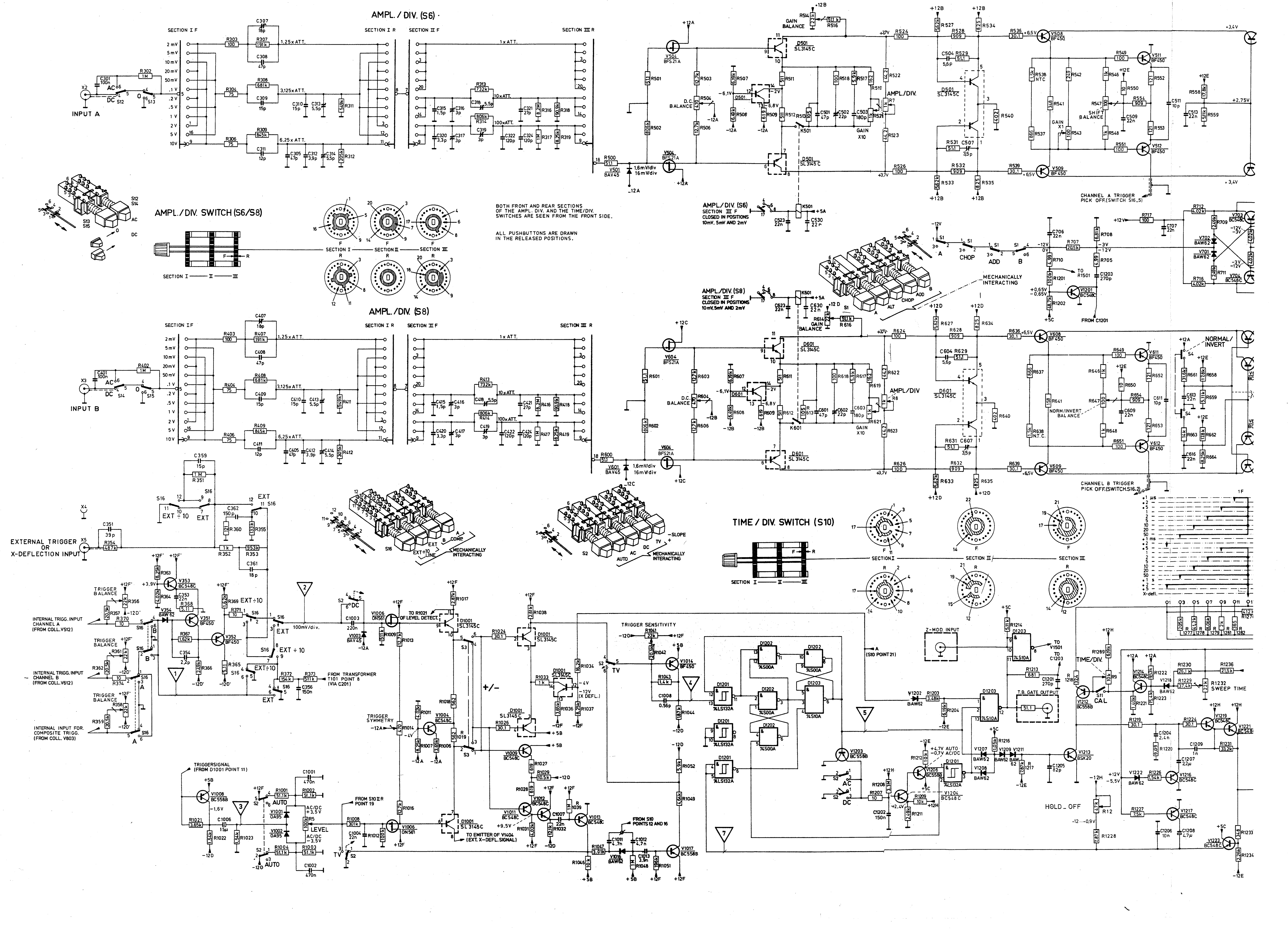

⊥
-12V
+5V
+12V
+38V
+180V
-180V
13
14
C.R.T G7
C.R.T. G5/G6
C.R.T. G2
LINE
R373
GRATICULE
ILLUMINATION
LAMPS
MAINS SWITCH
(S17)
-
DC POWER IN
+
MAINS
TRANSFORMER
VOLTAGE QUINTUPLER
FOCUS(R6)
C.R.T. K -1500V
FOCUS(R6)
C.R.T. F
C.R.T. F
VOLTAGE QUINTUPLER
MAT 229

Fig. 3.37. Power supply unit


AMPL./DIV. (S6)

AMPL./DIV. SWITCH (S6/S8)

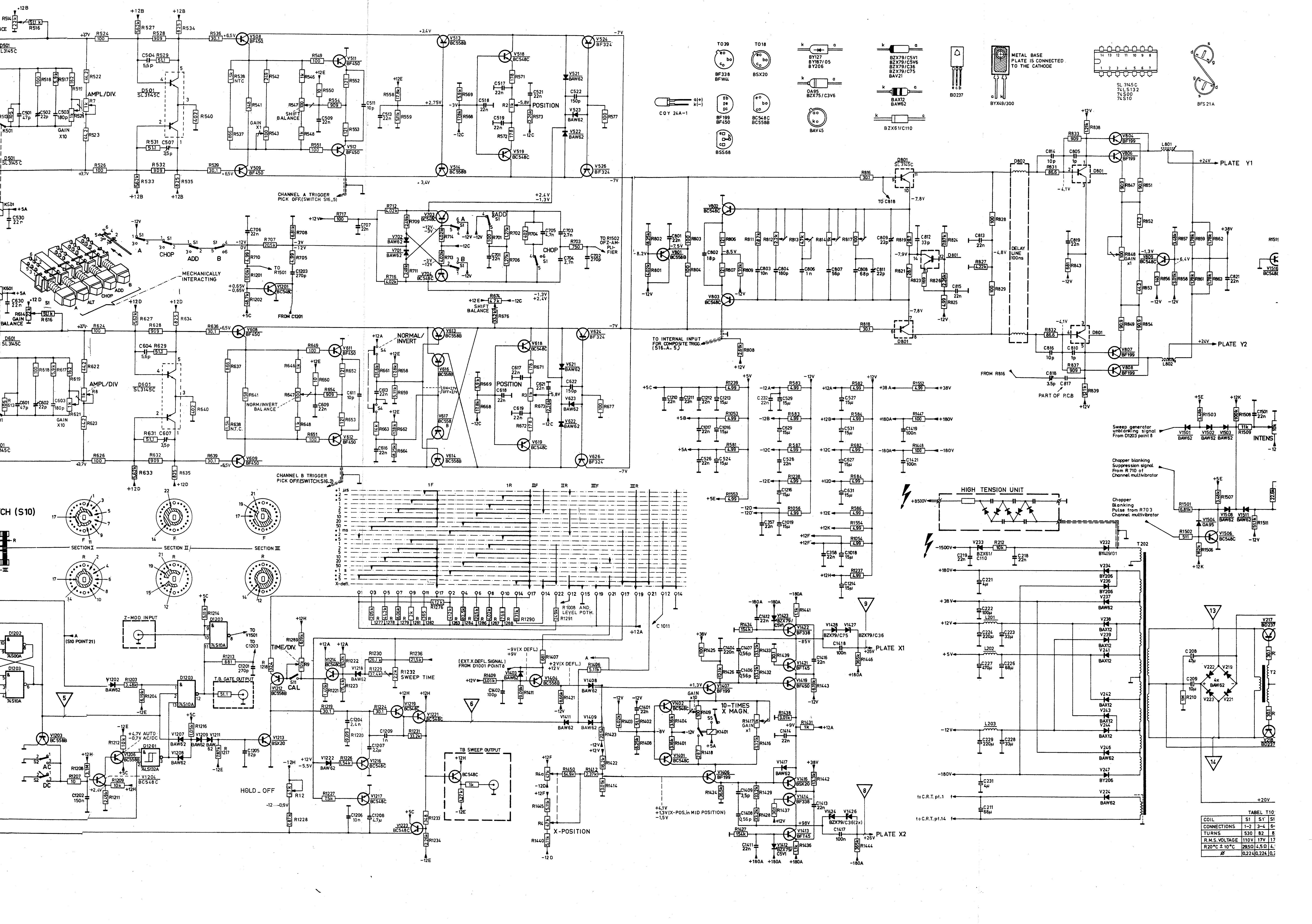
AMPL./DIV. (S8)

BOTH FRONT AND REAR SECTIONS OF THE AMPL. DIV. AND THE TIME/DIV. SWITCHES ARE SEEN FROM THE FRONT SIDE.

ALL PUSHBUTTONS ARE DRAWN IN THE RELEASED POSITIONS.

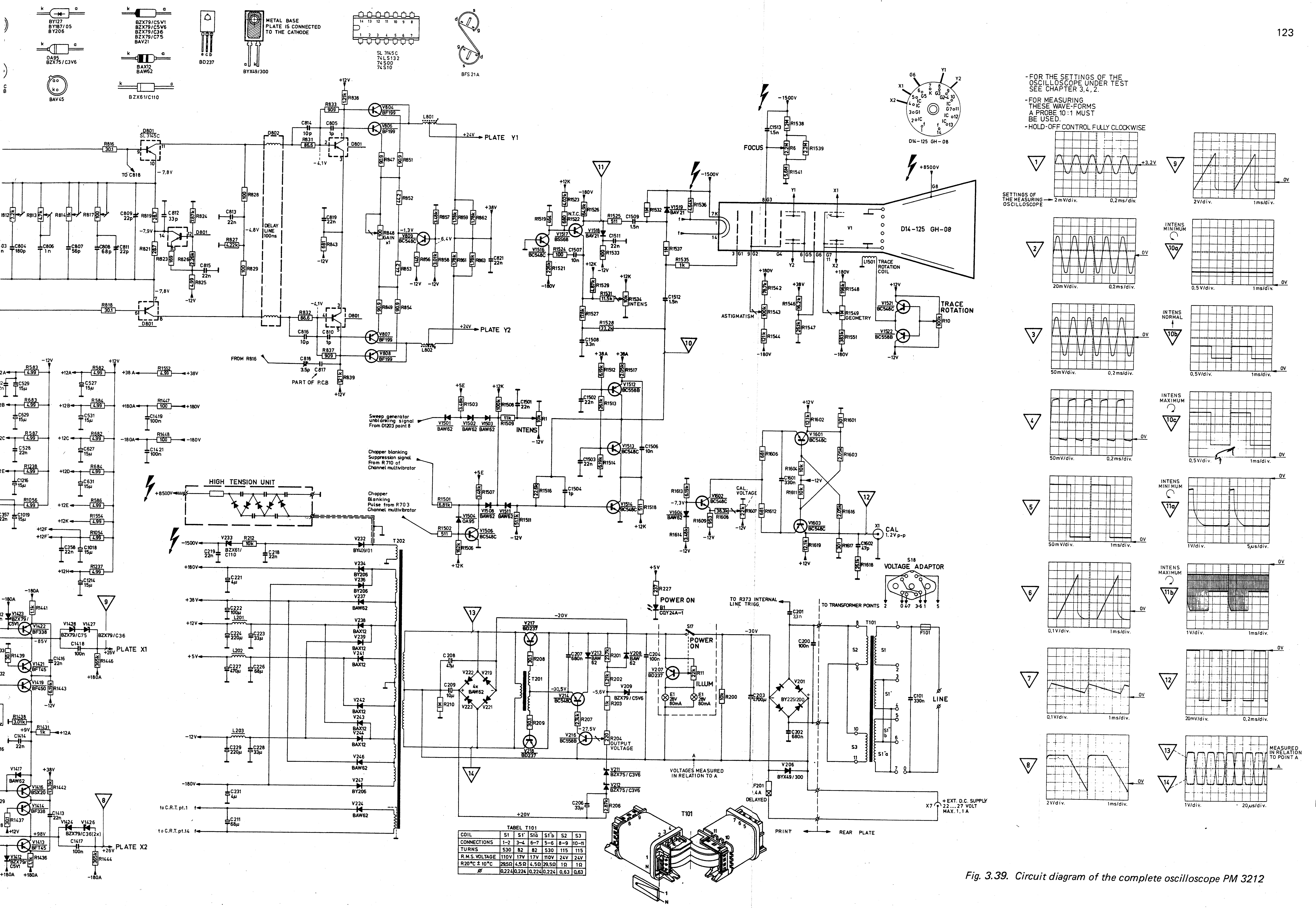
TIME / DIV. SWITCH (S10)

INPUT A
INPUT B
EXTERNAL TRIGGER OR X-DEFLECTION INPUT
SECTION I F
SECTION I R
SECTION II F
SECTION III R
2mV
5mV
10mV
20mV
50mV
.1V
.2V
.5V
1V
2V
5V
10V
1,25 x ATT.
3,125 x ATT.
6,25 x ATT.
1 x ATT.
10 x ATT.
100 x ATT.
AC
DC
S12
S13
S14
S15
SECTION I — II — III
SECTION I
SECTION II
SECTION III
AMPL./DIV. (S6) SECTION III F CLOSED IN POSITIONS 10mV, 5mV AND 2mV
AMPL./DIV. (S8) SECTION III F CLOSED IN POSITIONS 10mV, 5mV AND 2mV
GAIN BALANCE
D.C. BALANCE
AMPL./DIV.
GAIN X10
SHIFT BALANCE
GAIN X1
CHANNEL A TRIGGER PICK OFF (SWITCH S16_5)
CHANNEL B TRIGGER PICK OFF (SWITCH S16_2)
NORMAL/INVERT
NORM/INVERT BALANCE
A
CHOP
ADD
B
ALT
MECHANICALLY INTERACTING
FROM C1201
TO R1501
EXT ÷ 10
EXT
COMP.
LINE
AUTO
TV
-SLOPE
+
S16
S2
TRIGGER BALANCE
INTERNAL TRIGG. INPUT CHANNEL A (FROM COLL. V512)
INTERNAL TRIGG. INPUT CHANNEL B (FROM COLL. V612)
INTERNAL INPUT FOR COMPOSITE TRIGG. (FROM COLL. V803)
TRIGGER SYMMETRY
TRIGGERSIGNAL (FROM D1001 POINT 11)
LEVEL
FROM S10 II R POINT 19
FROM TRANSFORMER T101 POINT 8 (VIA C201)
100mV/div.
TO R1021 OF LEVEL DETECT.
TO EMITTER OF V1404 (EXT. X-DEFL. SIGNAL)
TRIGGER SENSITIVITY
FROM S10 POINTS 12 AND 16
(X DEFL.)
+/-
S3
Z-MOD. INPUT
T.B. GATE OUTPUT
TO V1501
TO C1203
TIME/DIV.
CAL
SWEEP TIME
HOLD_OFF
(S10 POINT 21)
1 μs
1 ms
1 s
X-defl.
74LS132A
74S00A
74S10A
SL3145C
BF450
BFS21A
BC548C
BC558B
BSX20
BAW62
BAV45
ON561
OA95


AMPL/DIV.
GAIN X10
D501 SL3145C
POSITION
SHIFT BALANCE
CHANNEL A TRIGGER PICK OFF.(SWITCH S16_5)
CHOP
ADD
ALT
MECHANICALLY INTERACTING
NORMAL/ INVERT
NORM/INVERT BALANCE
CHANNEL B TRIGGER PICK OFF.(SWITCH S16_2)
TO R1502 OFZ-AMPLIFIER
DELAY LINE 100ns
PLATE Y1
PLATE Y2
TO INTERNAL INPUT FOR COMPOSITE TRIGG. (S16_A_5)
FROM R816
PART OF P.C.B
CQY 24A-1
METAL BASE PLATE IS CONNECTED TO THE CATHODE
Sweep generator unblanking signal From D1203 point 8
Chopper blanking Suppression signal From R710 of Channel multivibrator
Chopper Blanking Pulse from R703 Channel multivibrator
HIGH TENSION UNIT
INTENS
SECTION I
SECTION II
SECTION III
X-defl.
Z-MOD INPUT
T.B. GATE OUTPUT
TIME/DIV.
CAL
SWEEP TIME
HOLD_OFF
TB SWEEP OUTPUT
(EXT.X.DEFL.SIGNAL) FROM D1001 POINT8
10-TIMES X MAGN.
X-POSITION
PLATE X1
PLATE X2
AC
DC
+4,7V AUTO -0,7V AC/DC

TABEL T10

COIL	S1	S1′
CONNECTIONS	1–2	3–4
TURNS	530	82
R.M.S. VOLTAGE	110V	17V
R20°C ± 10°C	29,5Ω	4,5Ω
Ø	0,224	0,224


BY127
BY187/05
BY206
BZX79/C5V1
BZX79/C5V6
BZX79/C36
BZX79/C75
BAV21
OA95
BZX75/C3V6
BAX12
BAW62
BD237
METAL BASE PLATE IS CONNECTED TO THE CATHODE
BYX49/300
SL 3145C
74LS132
74S00
74S10
BFS 21A
BAV45
BZX61/C110
D801
SL 3145C
D802
DELAY LINE 100ns
V804 BF199
V806 BF199
V807 BF199
V808 BF199
L801
L802
PLATE Y1
PLATE Y2
FROM R816
PART OF P.C.B
GAIN x1
V809 BC548C
HIGH TENSION UNIT
+8500V
-1500V
FOCUS
ASTIGMATISM
GEOMETRY
TRACE ROTATION COIL
TRACE ROTATION
D14-125 GH-08
INTENS
Sweep generator unblanking signal From D1203 point 8
Chopper blanking Suppression signal From R710 of Channel multivibrator
Chopper Blanking Pulse from R703 Channel multivibrator
CAL. VOLTAGE
CAL 1,2V p-p
VOLTAGE ADAPTOR
POWER ON
ILLUM
OUTPUT VOLTAGE
VOLTAGES MEASURED IN RELATION TO A
TO R373 INTERNAL LINE TRIGG.
TO TRANSFORMER POINTS
LINE
F101
F201 .4A DELAYED
+EXT. D.C. SUPPLY 22...27 VOLT MAX. 1,1 A
PRINT
REAR PLATE
T101
T201
T202
PLATE X1
PLATE X2
to C.R.T. pt.1
to C.R.T. pt.14
SETTINGS OF THE MEASURING OSCILLOSCOPE
2mV/div. 0,2ms/div.
20mV/div. 0,2ms/div.
50mV/div. 0,2ms/div.
50mV/div. 1ms/div.
0,1V/div. 1ms/div.
2V/div. 1ms/div.
0,5V/div. 1ms/div.
1V/div. 5μs/div.
20mV/div. 0,2ms/div.
1V/div. 20μs/div.
+3,2V
0V
INTENS MINIMUM
INTENS NORMAL
INTENS MAXIMUM
MEASURED IN RELATION TO POINT A

- FOR THE SETTINGS OF THE OSCILLOSCOPE UNDER TEST SEE CHAPTER 3,4,2.
- FOR MEASURING THESE WAVE-FORMS A PROBE 10:1 MUST BE USED.
- HOLD-OFF CONTROL FULLY CLOCKWISE

TABEL T101

COIL	S1	S1′	S1″a	S1″b	S2	S3
CONNECTIONS	1–2	3–4	6–7	5–6	8–9	10–11
TURNS	530	82	82	530	115	115
R.M.S. VOLTAGE	110V	17V	17V	110V	24V	24V
R20°C ± 10°C	29,5Ω	4,5Ω	4,5Ω	29,5Ω	1Ω	1Ω
⌀	0,224	0,224	0,224	0,224	0,63	0,63

Fig. 3.39. Circuit diagram of the complete oscilloscope PM 3212

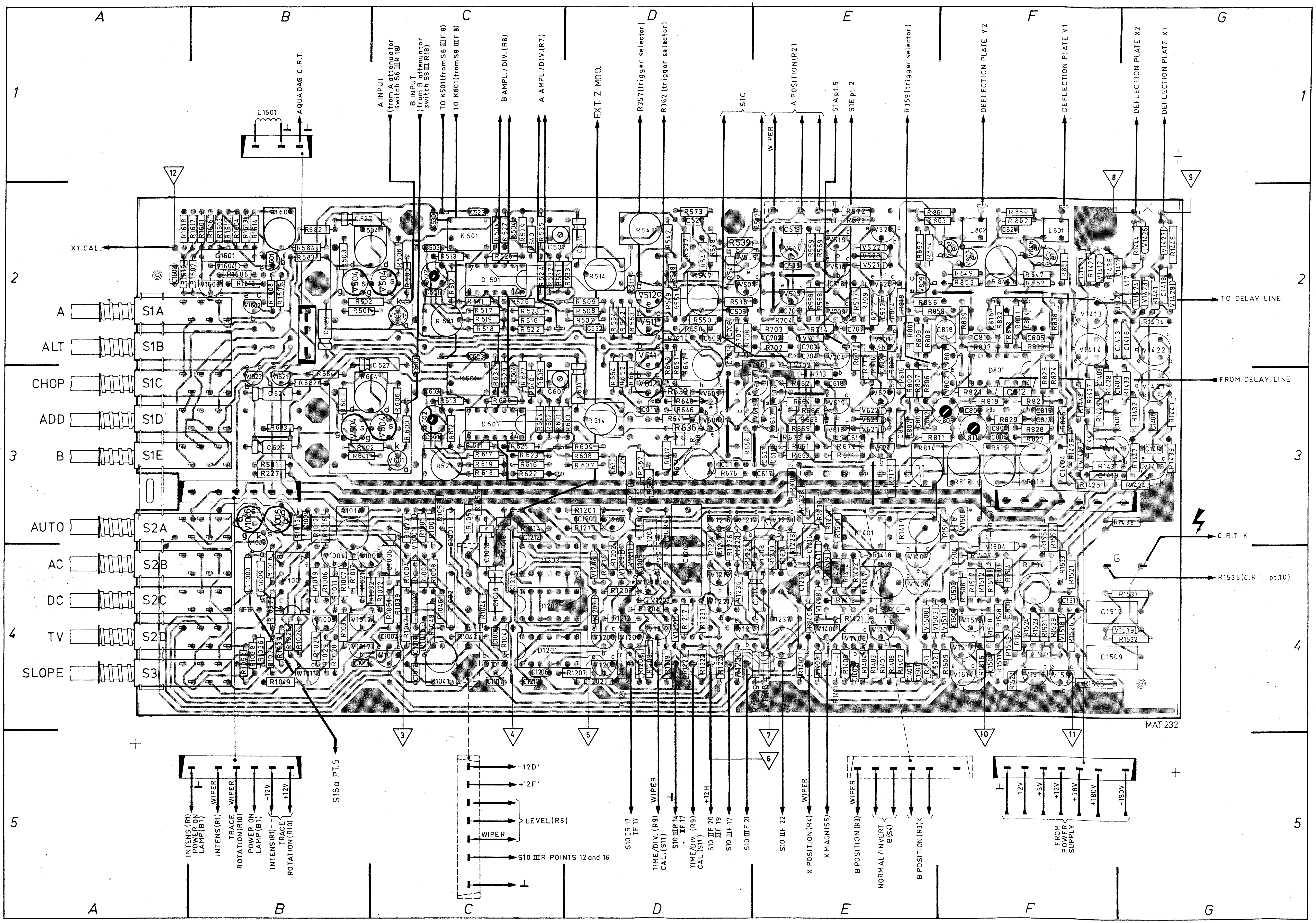

A
B
C
D
E
F
G
1
2
3
4
5
L1501
AQUADAG C.R.T.
A INPUT (from A attenuator switch S6 IIIR 18)
B INPUT (from B attenuator switch S8 III R18)
TO K501 (from S6 III F 8)
TO K601 (from S8 III F 8)
B AMPL./DIV. (R8)
A AMPL./DIV. (R7)
EXT. Z MOD.
R357 (trigger selector)
R362 (trigger selector)
S1C
WIPER
A POSITION (R2)
S1A pt.5
S1E pt.2
R359 (trigger selector)
DEFLECTION PLATE Y2
DEFLECTION PLATE Y1
DEFLECTION PLATE X2
DEFLECTION PLATE X1
X1 CAL.
TO DELAY LINE
FROM DELAY LINE
C.R.T. K
R1535 (C.R.T. pt.10)
A
ALT
CHOP
ADD
B
S1A
S1B
S1C
S1D
S1E
AUTO
AC
DC
TV
SLOPE
S2A
S2B
S2C
S2D
S3
INTENS (R1) POWER ON LAMP (B1)
INTENS (R1)
WIPER
TRACE ROTATION (R10)
WIPER
POWER ON LAMP (B1)
INTENS (R1) -12V
TRACE ROTATION (R10) +12V
S16a PT.5
-12D'
+12F'
LEVEL (R5)
WIPER
S10 III R POINTS 12 and 16
S10 I R 17 I F 17
TIME/DIV. (R9) CAL. (S11)
WIPER
S10 III R 14 II F 17
TIME/DIV. (R9) CAL. (S11)
+12H
S10 II F 20 III F 19
S10 III F 17
S10 III F 21
S10 II F 22
X POSITION (R4)
WIPER
X MAGN (S5)
B POSITION (R3)
WIPER
NORMAL/INVERT B (S4)
B POSITION (R3)
-12V
+5V
+12V
+38V
+180V
-180V
FROM POWER SUPPLY
MAT 232
3
4
5
6
7
8
9
10
11
12

Fig. 3.38. Vertical amplifier unit with upper side tracks

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① *Country*	② *Day Month Year*	③ *Typenumber /Version*	④ *Factory/Serial no.*
3 2	1 5 0 4 7 5	O P M 3 2 6 0 0 2	D O 0 0 7 8 3

CODED FAILURE DESCRIPTION ⑥

⑤ *Nature of call*	*Location*	*Component/sequence no.*	*Category*
☐ Installation		T S 0 6 0 7	5
☐ Pre sale repair		R 0 0 6 3 1	2
☐ Preventive maintenance	0 0 2 1	9 9 0 0 0 1	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ 1 2 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 3 2 = Switzerland

②Day Month Year 1 5 0 4 7 5 = 15 April 1975

③Type number/Version O P M 3 2 6 0 0 2 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number D O 0 0 7 8 3 = DO 783 These data are mentioned on the type plate of the instrument

⑤ Nature of call: Enter a cross in the relevant box

⑥ Coded failure description

Location

☐☐☐☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric, the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000	Unknown/Not applicable
990001	Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002	Knob (incl. dial knob, cap, etc.)
990003	Probe (only if attached to instrument)
990004	Leads and associated plugs
990005	Holder (valve, transistor, fuse, board, etc.)
990006	Complete unit (p.w. board, h.t. unit, etc.)
990007	Accessory (only those without type number)
990008	Documentation (manual, supplement, etc.)
990009	Foreign object
990099	Miscellaneous

Category

☐

0	Unknown, not applicable (fault not present, intermittent or disappeared)
1	Software error
2	Readjustment
3	Electrical repair (wiring, solder joint, etc.)
4	Mechanical repair (polishing, filing, remachining, etc.)
5	Replacement (of transistor, resistor, etc.)
6	Cleaning and/or lubrication
7	Operator error
8	Missing items (on pre-sale test)
9	Environmental requirements are not met

⑦ Job completed: Enter a cross when the job has been completed.

⑧ Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

☐☐ 1 2 = 1,2 working hours (1 h 12 min.)

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OSCILLOSCOPE PM 3216

Already published: –

Subject: 1. Alteration of the /01 and /02 versions
2. Alteration of the /03 version
3. Survey of publications to be used for the several versions

1. **During the production of the /01 version the following modifications are introduced:**

- To improve the HF response, capacitors C506 and C606 are added in parallel with R517 and R617 resp. The value is 3,9pF . . . 15pF
- R518 and R618 value was 100 Ω new 909 Ω (5322 116 54545)

During the production of the /02 version the following modifications are introduced:

- To obtain a better shift balance adjustment the following resistors are changed:
  R546 was 1k Ω new 953 Ω 5322 116 54547
  R547 was 100 Ω new 220 Ω 4822 100 10019
  R548 was 1k Ω new 953 Ω 5322 116 54547
- To simplify production the following values are changed:

R812	was	2,2k Ω	new	4,7k Ω	5322 100 10114
R813	was	4,7k Ω	new	10k Ω	5322 100 10113
R814	was	1k Ω	new	2,2k Ω	5322 101 14008
C808	was	68pF	new	47pF	4822 122 31072
C809	was	22pF	new	40pF	4822 125 50092
C811	was	22pF	new	40pF	4822 125 50092

- To improve the quality, trimming capacitor C318 5,5pF is changed into another type of 3pF (5322 125 54026)
- To prevent oscillations in the Y-amplifier C1402 is changed from 100pF to 1nF (4822 122 31175)
- To improve the time base accuracy two resistors have new values
  R1290 was 931k Ω new 953k Ω
  R1291 was 249k Ω new 261k Ω
- To protect the power supply as fuse is added in the line which connects the emitter of V207 and C204 (F202, 1,4A d.a. 4822 253 20023)
- To improve the quality, diodes V201, V202, V203 and V204 are replaced by a bridge rectifier V201 BY 225 - 200 (4822 130 50312)

2. **During the production of the /03 version the following modifications are introduced:**

- To obtain a better "gain X1" adjustment R852 and R853 are changed from 44,2 Ω to 55,1 Ω (5322 116 54442)
- To prevent oscillations two capacitors of 33pF (4822 122 31057) are added:
  C510 between R552/R553 and ground
  C610 between R652/R653 and ground

3. Publications to be used for version:

Version	Manual	Service information
/01	9499 440 20202	OSC 81
/02	9499 440 20202	OSC 81
/03	9499 443 00802	OSC 81 part 2 only

-NOTE: For the PM 3216B the above mentioned manuals together with manual 9499 443 01202 have to be used.